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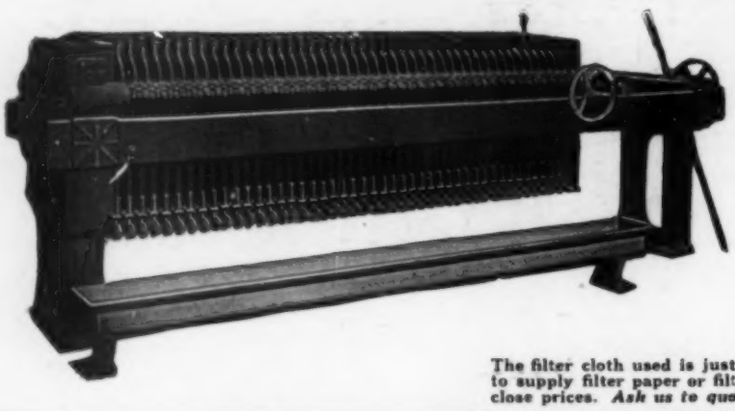

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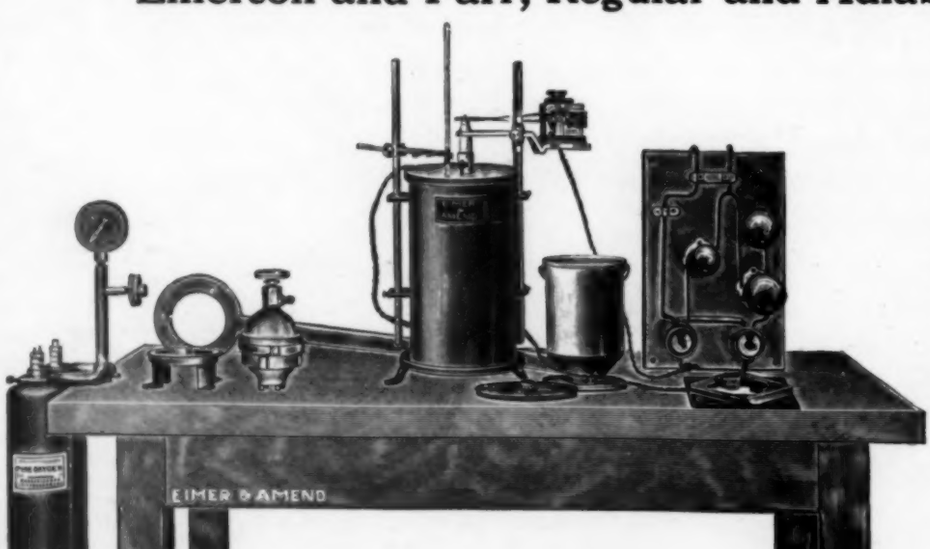

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Markdown Sale In Technical Men

EVERY day now adds to the number of men trained in chemistry or chemical engineering who are embarking on their technical careers after finishing their college education. Therefore this is the time of year for retrospect and forecast. To one who has been in industrial work for a number of years and who has a pessimistic turn of mind, the entry of hundreds of young men into this particular profession is always a time for wailing and gnashing of teeth. "How many young men!" he cries. "What a large percentage of the total will remain mired in routine work and never rise to positions of authority or prominence or power!" To him let it be said that such is the case in any profession, in any walk of life. Few ever attain the top, and if many did attain the top, there would be yet another top to which only a few would attain. That need not be a ground for pessimism. It is a condition of our social and industrial order.

We ought, however, to remember this—that more of opportunity can be placed in the paths of men entering our profession and it lies in our power to do this. Some years ago a cry went up in the electrical industry that there were too many electrical engineers, and many sage comments were advanced at that time. Among them was the suggestion that the way out of the difficulty was to produce fewer electrical engineers. Fortunately for our industrial order, a wiser plan was evolved and more positions were made available for men trained in electrical engineering. Sales work, purchasing work, accounting work, non-technical work of many descriptions were opened to technically trained men in the electrical field. So it should be in chemistry, and now is the time to start! Even now, prophets are crying that we should diminish the number of chemical graduates. How foolish this would be, and yet how inevitable it is going to be if we do not find new outlets for them. Your company may need a salesman, or a purchasing agent, or a clerk in the purchasing office, or there may be openings in the cost-accounting department. Use your influence to get young technical men for this work. They will fall into it admirably and there is a big future for technical men in most of these fields. Perhaps you do not know of any opening. Search around and find out if there aren't openings in those departments. Young technical men will often be very glad to get the wages of a clerk in order to learn the ways of the department. They will be as well paid as they would be in a routine laboratory or as a beginner in a plant. Three months from now ask yourself this question (perhaps we shall ask it for you): How many chemists have I placed, how many of this year's crop, in either technical or non-technical work? To those who do not see a duty in this, we recommend a period of solitary meditation.

A Plot to Traffic In College Degrees

SOMETIMES the most innocent appearing advertisement leads to diverting circumstance and entertainment. Take for example the experience of a correspondent who answered an advertisement in one of the New York papers from someone who wanted to get in touch with people in South and Central America, either directly or through an agent having a wide circle of acquaintance in those countries.

In answer to the advertisement an appointment was made with the advertiser, who introduced himself as "Dr. SORGEN" and represented himself as president of a college in New Jersey, the name of which was unfamiliar and made no impression. Conversation opened in the approved manner, but the good doctor seemed loath to come directly to the business in hand and apparently preferred to spar for a round or two for the proper opening. The subject of education was brought up and naturally the conversation turned to college degrees. Did Dr. SORGEN'S auditor think that people in Central and South America were interested in higher education, and particularly in acquiring the coveted degrees granted to graduates and post-graduates of our higher institutions of learning? Sensing the possibility of adventure, our correspondent readily fell in with Dr. SORGEN'S line of investigation and assured him that the inhabitants of South and Central America deeply appreciated the advantages of higher education and had nothing short of a passion for the letters that can be tacked on to the names of those who rightly complete college courses.

With these preliminaries out of the way, progress was more rapid and Dr. SORGEN came to the point and proposed an alliance with our correspondent whereby he was to beat the bush in South and Central America for suckers for fake college degrees to be granted by Dr. SORGEN'S college. The proceeds were to be split on a 50-50 basis. The versatile doctor did not propose to confine himself to his own institution of learning, but he assured his prospective partner that engineering degrees, for example, could be obtained from a number of prominent institutions. Could he, for example, obtain the degree of Electrical Engineer from Massachusetts Institute of Technology? Yes indeed! But the doctor hastened to explain that a student could not pick the college from which to receive his degree, because they were given from different institutions in turn and one might catch Tech, while again he might get his degree from another college. Medicine, law, engineering, science and the arts were in the doctor's repertoire.

Efforts have since been made to entangle Dr. SORGEN in the meshes of the law, but he has developed a quality of wariness that has made it difficult to catch him. He declined to engage in correspondence

and apparently has dropped out of sight, preferring to forego the pleasure of bestowing degrees and granting diplomas for a stipulated sum—an avocation that ultimately might restrict his liberty. Our South American friends may well beware of "Dr. SORGEN" or any of his type who offers for sale the honorable evidences of an education earned in a reputable institution.

The War Is Over—
We Harbor No Malice

IN OUR ISSUE of March 8 we commented on "A German Chemist's View of Conditions in America." It had to do with an address he made in Germany after a visit to the United States, and now he writes to us in protest. We erred, he says, in translating some of his observations. We have mislaid the report, but are prepared to stand corrected, as he is a man of high character, wholly trustworthy and above dissembling.

The errors were not of leading importance. His protest is rather against the tone of our writing and the observations that we made of the curious workings of the German mind. His point of view is that the Germans want to be judged on their merits, in all fairness, and without the prejudice that he believes has been instigated here by "English and French lies."

The war is over, and we are resolved to be as generous as we can to Germans. We are all neighbors on the same earth, and we must get along together somehow. Like all the rest of the world they—and we too—are threatened with the "dictatorship of the proletariat," which means the rule of the incompetent, and this in turn means the breakdown of civilization which follows anarchy and disorder. We see it in Russia.

The difficulty in discussing Germany and Germans is due to a geographic difference in opinion. Outside that country the opinion prevails and always will prevail that Germany and the Germans stand guilty before the bar of the world's justice. To set down the indictment would only beget bad blood. We have no desire to do so. The German opinion appears to be the very opposite; that they, like others, participated in the great conflict, that they showed great bravery, and that they are no more guilty than any other participant. They do not ask for forgiveness, while we wonder that they are not ashamed. Some day when we know more than we do now we may be able to discuss the biology of opinion as a problem of calm, scientific research.

Once we were in a mixed company at lunch with the late THEODORE ROOSEVELT. A lady of the party who was an active social worker tried to steer the conversation over to some of the economic aspects of prostitution, and to get him to talk about it. The situation became rather tense. "Madam," said T. R. when her questioning had become categorical, "there was an old Frenchman who said that some subjects may only be discussed with safety in terms of statistics. I think he was right."

Our business has to do with pure and applied chemistry, and we do not discriminate whether it be of British, French, Italian, German or American origin. We take our hats off to the great work done by German chemists. They have added vastly to human knowledge and understanding. Let's stop right there and not upset the apple-cart by talking about what Germans did before and during the war.

A Significant
Chemical Merger

WE ARE in the midst of a season of mergers. Reports of combinations and consolidations are heard from all sides and in all industries. Just at present the public's attention is focused on the activities of the steel companies, but those of us in the chemical industry should not lose sight of a merger within our own ranks which would appear to carry with it more than usual significance. The purchase of the Condensite Co. of America by the Redmanol company, followed by the merging of both with the General Bakelite Co., is the climax of a remarkable story of industrial development. It is the outgrowth of the long-drawn-out litigation in which the courts broadly sustained the patents of Dr. L. H. BAEKELAND and recognized his pioneer work in the development of the commercial manufacture of synthetic resins and related products.

The chemical industry will be the first to welcome this amicable settlement of a historic controversy. We cannot help feeling that the merger opens the way to a wonderful opportunity for further progress and expansion. The constituent companies will continue on a competitive basis of manufacture; but there will be an exchange of information obtained in the several research laboratories. Thus the conditions will be most favorable for progress in the art of manufacture and for service to the industries consuming the product.

Mergers, for some reason or other, are always regarded with suspicion, and the present consolidation may arouse some criticism. However, if we have the right understanding of the Sherman law, it is not the actual consolidation of companies that is illegal, but rather the "combination in restraint of trade." From our own viewpoint, our respect for the technical men who are at the head of the new Bakelite Corporation and our confidence in their high-principled and able direction are such that we can look forward only to continued progress and increased service in this thoroughly American industry.

Dr. Jekyll
Boll Weevil

PROBABLY a very large percentage of the general public as well as the scientific and technical public believe that the boll weevil is the *sacre albion* of the South. In many ways this is true, but there is an interesting side of the boll weevil question which has received some publicity and deserves further emphasis as being a significant economic factor in the country. In many parts of the South the boll weevil cleaned out the cotton crop for several years and the planters in desperation began to plant other crops besides cotton. In this way they learned for the first time and of dire necessity the distinct advantage of being emancipated from the complete domination of old man cotton. As a one-crop district the South has always suffered. Planters had to bargain away their crops to brokers at a distinct disadvantage simply because they had no other weapons with which to bargain. Now in many communities with two or three or four other large crops cotton has still a major rôle, but it emancipates the planter from domination of the speculative buyer.

In one town in the South they have raised a statue to the boll weevil. This seems like a curious kind of grim humor, but the fact is that the town has for the first time in its career become a flourishing place, where

prosperity roosts occasionally. Previous to the invasion of the boll weevil the town was cotton poor. A good crop or a poor crop made very little difference. There seemed to be no large returns to the planter.

In this issue of CHEM. & MET. Mr. AMBRUSTER presents one phase of the fight which the government and the cotton planters are waging against the boll weevil. Calcium arsenate, the Nemesis of the boll weevil, developed by Dr. R. B. COAD of the Department of Agriculture and his energetic workers, is a peculiar commodity. Made from material which is a byproduct and whose value is not at all dependent on the demand, calcium arsenate has a price which is almost marginal as far as its use in cotton is concerned. Furthermore the cotton crop must compete for it with other crops which can afford to pay a much higher price for insecticides.

The fight against the boll weevil, however, is vital to the country's welfare and a knowledge of the conditions underlying that fight is most timely. The boll weevil has proved to be a Dr. Jekyll in waking some of the South to the folly of depending on one crop. He is essentially Mr. Hyde, however, and the war will stop only at extermination. At present calcium arsenate seems to be the way toward success.

The Demand for Steel Products in 1921

IN AN "off" year in the steel industry the demand for the different descriptions of steel does not decrease in equal proportions. Some steel products are relatively staple in character, while others exhibit wide fluctuations in demand from time to time. The full statistics of steel production in 1921, recently issued by the American Iron and Steel Institute, are of particular interest on this account.

It required no official statistics, of course, to inform us that the production of steel, as a whole, in 1921 was very light, but the exact measure is now furnished. The production of steel ingots was 19,184,084 gross tons, or less than half the production in 1916, 1917, 1918 or 1920. The backset was not only the greatest in tonnage but also the greatest in percentage ever experienced. In 1914 there was a 25 per cent backset from the best previous record, and in 1908 a 40 per cent backset.

The habit of thinking of steel production in terms of percentage of capacity is so common that this relation is given more importance than it deserves. Steel is so useful and its consumption is so interlocked with our various industrial and commercial activities that the amount of productive capacity is really only an incident. Considering the country as an industrial unit, we are engaged in consuming steel rather than in producing steel. It is the consumption that counts. It is a detail that the 1921 production was only about 35 per cent of the productive "capacity." It is very doubtful whether this "capacity" is really potential, whether it would today be possible to find enough transportation facilities and enough workmen to go with the production and consumption of steel at a rate equal to the physical capacity of the steel-making units. The existing "capacity" is more than double the actual production in 1910, which made a new record at the time, but the census reports only 9 per cent more persons "gainfully occupied" in 1920 than in 1910.

One of the most staple lines of steel production is the wire nail. As there were light exports in 1921, only 629,650 kegs, while five years in the past showed exports of more than 2,000,000 kegs, it is best to make comparisons by domestic consumption, which amounted to 11,259,762 kegs in 1921, or more than in any year prior to 1909, and only 22 per cent under the record, made in 1917.

Again, we may think of plates and sheets as not very different in character, but if we take sheets 13 gage and thinner and sheets and plates 12 gage and heavier (disregarding tin mill production entirely), we find that the 1921 production of 13 gage and lighter, 1,367,688 tons, was 54 per cent of the record output, made in 1920, and was greater than the output in any year prior to 1910, while the production of 12 gage and lighter, 1,804,453 tons, was only 33 per cent of the record, made in 1918, and was less than half the output in any one of the five years 1916 to 1920, while it was only 64 per cent of the output in 1910.

One may consider tin plate more of a staple than pipe, but pipe showed a very fair production in 1921, 1,987,442 tons, or 34 per cent under the record year, 1920, and 25 per cent under the second best year, 1916. Tin plate showed a production of only 793,198 tons, or only 52 per cent of the record output. The light production was largely because holders of goods packed in tin plate containers in 1920 at high cost were indisposed to liquidate by taking losses and named prices the buying public was unwilling to pay.

The Courage Of the Pioneer

IN THAT very charming comedy, "Little Old New York," there is a scene in which *John Jacob Astor*, the rugged Dutch leader of the community, upbraids a number of wealthy young men because of their unproductive and dissolute lives. "Habits such as yours," he scornfully remarks, "can never produce success such as mine." One of the young men protests to *Mr. Astor* that conditions are very different now from the time when he was a young man. There was more opportunity in those days. And yet young *Cornelius Vanderbilt* was just beginning his career at that moment. So it is with every generation. There appears to be no opportunity to most people until the pioneer has achieved success, and in achieving it reveals the opportunities that existed.

Besides vision it is necessary also to have courage. With vision only we have the dreamer who falls short of accomplishment. Courage is the energizer which picks up the dream and carries it to success.

Those who were fortunate enough to hear HERBERT DOW talk at the recent New York Section meeting of the A.C.S. on the early history of the company which now bears his name must be impressed with the high order of courage required to persist through the first five discouraging years of effort. When Mr. DOW described the fourth or fifth plant which he had built, and remarked, with a twinkle in his eye, "Well, that plant didn't work very well either," and then went on to describe some of the troubles which occurred, we all could laugh with him in his successful retrospect. But at the same time the fourth or fifth plant failed to produce, and when the embryonic company found itself again bankrupt, then was the time when, without courage, failure would have been inevitable.

The combination of vision and courage is rare. The reward of such a combination is inevitable. The inspiration, to the young chemist particularly, of the stories of such pioneers is beyond estimation. Let their stories be broadcasted.

Readers' Views and Comments

Spontaneous Formation of Martensite

To the Editor of Chemical & Metallurgical Engineering

SIR:—The article on "X-ray Data on Martensite Formed Spontaneously From Austenite," by Edgar C. Bain, is of much interest, but it would seem that further information and consideration are necessary before accepting some of the statements and conclusions contained therein.

The analysis of the steel would not seem to me to be such as could be retained in the austenitic condition at room temperature, and the micrograph at 100 diameters would scarcely seem to be of high enough power to make sure that the structure is really austenitic.

Some of the grain boundaries look very much as if the metal had been burned, which, of course, would outline the gamma grain boundaries, while the alpha boundaries would be inside the gamma ones. It seems to me, as stated before, that further information is necesssary before it should be so strongly stated that the original structure was austenite and that in the course of time the room temperature has changed this to martensite.

S. W. MILLER.

Union Carbide & Carbon Research Labs., Inc.
Long Island City.

To the Editor of Chemical & Metallurgical Engineering

SIR:—In reading over Mr. Bain's contribution to your issue of March 23 entitled "X-ray Data on Martensite Formed Spontaneously From Austenite" I am struck by the incompatability of his data, as presented, with previous experience. The chemical composition given would indicate that the steel used could not possibly have been austenitic, with so low a content of C, Ni and Mn. Since, however, the micrograph, Fig. 27, shows a characteristic austenite structure, it seems probable that there is a misprint in the analysis. Accordingly I asume that the nickel content is 28.1 per cent and not 2.81 per cent. On this basis the results become intelligible.

It is quite likely that a steel of that composition would be in the austenitic condition as cooled to ordinary temperatures and that it could be transformed more or less completely to martensite by appropriate treatment, but not by the action of time alone. Hanson and Hanson[1] give temperature vs. electrical resistance curves for iron-nickel alloys which show clearly this possibility. Their alloy of 25.5 per cent Ni content has its maximum of Ar_2 at 108 deg. C. and another of 29.4 per cent Ni content at —25 deg. C. An alloy corresponding to Mr. Bain's analysis but with 28.1 per cent Ni would probably behave like their 29.4 per cent Ni alloy because of its higher content of other lowering elements. It would then be austenitic as cooled to some ordinary temperature, but there is no existing data indicating that it would change appreciably to martensite with time if the temperature were kept constant.

However, there is a possibility that the specimen was subjected to the vagaries of weather. If severely chilled, it may very well have gone through the Ar_2 transformation. Mary Andrews' has shown very definitely the effect on the crystal structure of chilling by dipping a previously austenitic iron-nickel alloy in liquid air. Besides becoming magnetic, the specimen changed over to the body-centered cubic form.

Unfortunately Mr. Bain does not give a complete history of his specimen, so one cannot decide whether he has real evidence of a previously unknown "spontaneous" change of austenite to martensite or not. There are also several other inconsistencies which confuse the reader. Fig. 1 is evidently not of the same area as Fig. 2. Whether the illumination is vertical or oblique, the grain contrast should show in it and twins would be expected also.

The apparent difference in grain size also requires explanation. It is not stated whether Fig. 6 is the result of repolishing and etching or is the original etched and polished surface. If the latter is the case, no definite change in the surface appearance would be expected to be visible at the magnification used, even though the specimen changed completely from austenite to martensite. Figs. 8 and 9 are evidently reversed. In consequence of this situation it can scarcely be held that the data presented bear out the implication of the title.

Bureau of Standards,
Washington, D. C.

HOWARD SCOTT.

To the Editor of Chemical & Metallurgical Engineering

SIR:—The paper entitled "X-Ray Data on Martensite Formed Spontaneously From Austenite" in the issue of CHEM. & MET. for March 22, 1922, was written not so much to establish spontaneously transformation as to present observations corroborating the view that martensite is essentially a fine-grained material.

Jeffries and Archer have offered this theory and the data afforded by the author's X-ray crystallographs verify it in a way which probably could not have been accomplished by the microscope.

It is only incidental that martensite with apparent grain size many times the true grain size—a condition desirable for the proof—was found in an unusual specimen. A quench from the melting point made so quickly as to hold a steel largely austenitic with relatively low content of the agents carbon, manganese and nickel is rather unique and it was thought that this fact might lend interest to the account. The author has been able to produce very nearly pure austenite from ordinary high-carbon steel with insignificant content of manganese and nickel by quenching in iced brine and these specimens also lost the face-centered cubic crystallinity by transformation to body-centered iron at room temperature after the lapse of several months.

The microphotographs were made to show the twinned structure characteristic of austenite in one case and the absence of the "chevron" markings of martensite at the higher magnifications. These were of course made on the freshly quenched material. Doubtless the change began very soon after quench.

Unfortunately, the numbers designating figures 8 and 9 were interchanged, probably due to an oversight in reading the proof of the article.

EDGAR C. BAIN.
CHARLES Y. CLAYTON.

[1] *J. Iron & Steel Inst.*, vol. 102, p. 39 (1920).
[2] *Phys. Rev.*, vol. 18, p. 245 (1921).

Calcium Arsenate for Boll Weevil Control, and the Arsenic Situation

The Insect Infestation of the Cotton Fields of the South Has Developed a New Branch of the Chemical Industries, the Growth of Which Will Be Controlled by Many and Conflicting Factors, Including the Available Supply of the Principal Raw Material

BY HOWARD W. AMBRUSTER

THE insect pests as a group are said to be the most powerful enemy of mankind today, the hazard to humanity being the starvation of the peoples of the earth through reduction of crops. And that part of the chemical industry which is devoted to the production of compounds for the destruction of insect pests is believed by those engaged in it to be the most hazardous of any industry based on applied chemistry from every standpoint. Of the insect pests which have been identified and combated by the combined ingenuity of agriculturists, entomologists and chemists, none has attained more prominence or greater disrepute than the Mexican, or cotton, boll weevil (*Anthonomus grandis*), which, though it does not attack a food crop, is equally as destructive from an economic standpoint as any insect now known. In the battle for the control of the boll weevil in the cotton states of the United States, after many methods have been tried by government officials and private investigators, the greatest encouragement that has resulted has been from the use of the compound known as calcium arsenate, $Ca_3(AsO_4)_2$. This product, made by the combination of arsenic acid and lime, is now manufactured in this country by about fifteen or twenty of the companies making agricultural insecticides.

Is a Shortage of White Arsenic Likely?

The probable increase in demand for calcium arsenate for boll weevil control has brought up the question as to whether the supply of commercial arsenic which is now available in this country and abroad is sufficient for any such quantity of calcium arsenate as some enthusiasts claim will be required annually within the next few years.

There are so many different factors, statistical and otherwise, which must be considered in reaching any conclusions on this subject that the latter are bound to be more or less controversial. But some phases of the situation are sufficiently defined to permit the contention that an acute shortage of arsenic probably will develop should the demand for calcium arsenate reach any sizable proportions. It must be acknowledged also that should the production of arsenic remain stationary, while the demand for calcium arsenate increases, the future program of the entomologists for the use of this spray for the cotton crop will be endangered.

That feature of the situation which is not appreciated by many of those directly interested in the industries affected is the fact that at present the world's available production of arsenic has no relation whatsoever to the market demand for the product. In this respect arsenic is somewhat unique among those products or commodities which may be described as basic raw materials. The white arsenic of commerce, or "arsenic oxide," is more correctly arsenic trioxide, As_2O_3 (also known as arsenious acid and arsenious anhydride). Practically all of this arsenic which is produced today is the byproduct of the smelters. It was first produced in the crude state at the smelters in what are known as bag houses attached to the furnace flues and in more recent years by the Cottrell process by electrical precipitation of the arsenical or black dust from the smelter fumes.

As the attorney said in advising his client, the latter's case had a "nuisance value" which made it worth while; just so is the arsenic production regarded by metallurgists and smelters. It is a nuisance and has a nuisance value only. It is usually regarded as the most objectionable content of the precious and semi-precious ores, and any ore is selected for its low arsenic content in preference to another ore equally available and valuable but containing a higher percentage of arsenic. It will be conceded generally that if it had not been for the legislation directed against the smelters on account of the damage done by their fumes, the use of arsenic as an agricultural spray material would have been seriously retarded from its inception for lack of sufficient supply of the raw material.

Method of Manufacture of White Arsenic

The crude arsenic as it is first collected varies in content all the way from 40 to 90 per cent As_2O_3, though the bulk of it approximates the higher level. To refine it to 99 per cent so that it is marketable as white arsenic, the crude must be treated one or more times in volatilizing furnaces, by which process the other ingredients in the original crude product are separated and driven off with the exception of a minimum ½ to 1 per cent of impurities which are found in all commercial white arsenic. The crude product varies greatly in percentage and character of impurities which are at times extremely difficult to reduce, and the smelters therefore sell a certain percentage of their output as off-grade arsenic testing between 90 and 99 per cent.

This off-grade arsenic can be used for a part of the market requirements, but is unsuitable for the most important use, which is the manufacture of arsenic acid, or H_3AsO_4, the first step in the production of the important arsenical insecticides, lead and calcium arsenate.

It should be obvious, therefore, that in case of sudden increase of the demand for arsenic we shall have to look elsewhere than to the smelters, which produce the crude because they cannot help themselves and refine it to make it marketable. The selling price has, therefore, no relation to the cost, but reflects in a way

an open bidding by the consumers for the given tonnage of arsenic which is available each season.

The real cost of production comprises, first, the transportation of the crude to the refining plant, the revolatilizing cost, which varies according to the number of treatments required, grinding if the product has solidified in the flues, and packaging for the market. If as an accounting policy a part of the actual cost of smelting is allocated to the arsenic byproduct as such, a considerable item may be added to the total cost of the refined white arsenic, and as the latter is now a standard market commodity of wide distribution, it is of course an entirely logical policy to divide total operating costs among all of the various products of the smelters. But this point should be taken into consideration when considering the actual cost of production in relation to selling price.

The direct production of arsenic from some of the many low-grade iron ores (mispickel or arseno-pyrites) containing a fairly high percentage of arsenic has been commercially attempted many times, but never with sufficient success to insure a stable enterprise. Should the demand increase to such a point as to put the market on a permanent level, about double its present selling price (6 to 7 cents per pound), many of these developments could undoubtedly be firmly established, but any such increase in the selling price of arsenic would seriously affect the cost of manufacture of calcium arsenate as well as all other arsenical spray materials. Calcium arsenate for boll weevil control must be sold at an even lower figure than it is at present to insure the utmost development of its use and value to the South.

On the other hand, spray materials for all other purposes and likewise all other uses for white arsenic, should necessity demand, can afford to pay increasing prices. This has been demonstrated in the recent past. So while it is a safe conclusion that the direct production of arsenic is a possible development at a higher price level for many other requirements, it does not follow that the increased supply thus made available will contribute to the protection of the cotton crop. Aside from the various known methods of direct production of commercial arsenic from mispickel, the only other alternative is the possible development of the production of arsenical compounds for spray requirements direct from an arsenical ore.

Use of Arsenate Ore as Short Cut

A short cut to the final product precludes the process of extracting the arsenic as As_2O_3 and its subsequent oxidation to As_2O_5, and requires an ore in which the arsenic is present in its natural state as an arsenate instead of an arsenite. Deposits of the latter classification are found in many parts of the United States and elsewhere, but there is only one known deposit of the former in any appreciable quantity, and its development, though contemplated for some years, is still in the future as a commercial enterprise. A very considerable saving in final cost would result should it prove to be practicable to produce the commercial arsenical sprays such as calcium and lead arsenate direct from an arsenical ore and without the successive steps of refining white arsenic and converting the arsenic to acid before combining with the lime or lead.

Extent of Market

Of the 16,000 tons of arsenic which it is estimated is now consumed annually in the United States, between 80 and 85 per cent is required by the insecticides and related industries such as the manufacture of weed killers and cattle dip. The bulk of the remainder of the total goes to the glass maker and for the manufacture of pharmaceuticals. Of the requirements for insecticides the largest part is converted into arsenic acid in about twenty-five different plants mostly located in the East and Middle West. The majority of these are small and operate only a few months in the year. The same intermittent schedule of operation applies to the other plants, about twenty in number, including those which compound spray materials like paris green direct from the white arsenic and those making weed killer and cattle dip. This irregularity of consumption has always brought the maximum demand within a few months for a basic raw material which is produced normally over the entire twelve months. The effect on the market price is obvious.

The other principal demand for arsenic, for the glass industry, is an all the year round requirement, as is also the limited use of arsenic acid for the production of arsepheminine, or salvarsan, and small requirements such as for rat poisons, preserving hides and the reduction of metallic arsenic. In times past arsenic was an important raw material for the dye industry, it being used in the production of fuchsine colors, but this method has been abandoned, and the industries enumerated above cover practically all the uses to which arsenic is now put.

Official figures indicate that the present production of byproduct arsenic in the United States is at the rate of approximately 12,000 tons annually, and the remainder consumed here comes mainly from Canada and Mexico and from Germany, Japan and Belgium.

The figures for the world's production of arsenic are exceedingly difficult to compile intelligently, as official statistics are irregular in classifying white arsenic with the crude, with ore content and with red arsenic and with the metal itself.

From such figures as are available, however, it is evident that the annual production of commercial white arsenic from all world sources is not much in excess of 30,000 tons when the smelters are at normal production, and the total is probably less than that figure during the last two years of restricted metal output.

A large quantity of arsenic was imported into this country in years past from Spain and England, as well as from Germany, but more recently the English supply has been consumed at home or gone elsewhere, and unsettled conditions in Europe since the war have permitted the Japanese producers to make considerable inroads on the importations to America. In addition to the countries named, arsenic is also produced in South Africa, Australia, Greece, Portugal and France, but in none of these countries is there any surplus for export to the United States.

The demand abroad is fairly stable and the uses are similar to those in the United States, though a much larger proportion of the total is consumed by the industries other than the agricultural sprays. Of the latter broad classification the use of arsenic for cattle dips is in much greater proportion abroad than in the United States. In South Africa, South America and Australia, where cattle raising is highly developed, the use of arsenic for dips preceded this use in the United States. All agricultural countries are using insect sprays in a greater degree than ever before, though nowhere to the same extent as the American farmer

and fruit grower. The cotton planter abroad has his own weevil problems to help along the consumption of arsenic. There is no reason to believe, therefore, that a normal or steady increase in the world's consumption of arsenic will not keep pace with any possible normal increase in the byproduct production of the smelters, and this leaves a margin of only a few thousand tons available at present prices for any abnormal increase in demand which the situation in the South may develop.

Loss Caused by Weevil

Anything like an exact estimate of the actual loss caused by the boll weevil must be an exceedingly argumentative conclusion, based on unreliable premises. The shiftless planter blames on the weevil everything which he cannot unload on the weather and the cotton traders; the intelligent cotton raiser in boll weevil districts tries every precaution or remedy recommended by government and state officials and admits that the weevil is at least largely responsible for the difference between a minimum and a maximum yield per acre. However, there can be no valid objection raised to the statement that the loss to the cotton grower due solely to the destruction by this one pest has already reached a total of hundreds of millions of dollars.

Poor Quality of Early Product

When the use of calcium arsenate was first advocated a few years ago, a number of manufacturers began to produce it. The quality of this first material was so irregular, however, that a great deal of distrust was developed, and this retarded greatly the use of calcium arsenate. In some sections the cotton crop was seriously injured by the high percentage of soluble arsenic. The resulting prejudice is so strong that it is very doubtful if the government can ever altogether overcome it. In addition to the poor quality of the product, the lack of knowledge of how to apply it also caused considerable damage to the cotton crops. It is perhaps not unnatural that the ignorant negro planters cultivating a few acres of cotton should be slow to learn the proper way to use the insecticide. Chemical manufacturers, however, have not the excuse of ignorance which the poor negro planter has and it is therefore not unreasonable to expect that they should have known better. The manufacture of calcium arsenate according to the chemical and physical specifications recommended by Dr. Coad, the government entomologist, is not a difficult problem, but many producers have found its manufacture tricky and many tons of material have been condemned by government agents.

Present Production and Future Estimate

The production of calcium arsenate thus far reached its high point in 1920, when upward of 5,000 tons was manufactured in the United States. Much of this was made too late for the 1920 season, and was carried over for 1921. On account of the condition of the South last year, the use of this spray did not develop as expected, and part of the 1920 production was carried in stock for the second year. In some quarters it is felt that the prospects this season are for an extremely heavy demand. The manufacturers, with last year's disastrous losses in view, have declined to pile up any new accumulation of stock ahead of the selling season, and it is entirely possible that the demand this season will exceed the available supply, though this is not likely, as there are large stocks in the Southern warehouses of many companies.

Such manufacturing capacity as the plants now have, if operated continually through the year, would be more than ample for any possible demand at present. In the recent past, however, the erratic market records for the product itself and for white arsenic, the principal raw material, have made it unwise to anticipate the demand before it actually comes about.

It is improbable that this marketing condition will continue to prevail should the demand for calcium increase as expected. But the estimating of just what the possible or probable increase shall be has led some of the producers far astray in the past and will probably continue to do so for years to come. One enthusiast in the early years of the use of calcium arsenate based his calculations on the number of acres planted in cotton in the South and the maximum amount of calcium arsenate which could be used per acre. The result was startling, and disastrous to those who were influenced by the figures. There was not enough manufacturing capacity available, or enough white arsenic in sight, to produce in a long period of years the amount of calcium arsenate which would be consumed in a single season on the basis of this simple calculation. Far below the figures of that brilliant statistician is a conservative estimate for the ultimate consumption of calcium arsenate. When that time will be reached and whether more effective means will be devised in the meantime only a reckless prophet would predict.

Problem of Price

It would be somewhat desirable to get a rough estimate of just how the price of calcium arsenate affects the extent of its use. Official recommendations from the Department of Agriculture advise the use of about 5 lb. of arsenate of lime per acre and at least four applications during the season, if the weevils are actually damaging the crop. Calcium arsenate now sells at from 9 to 12 cents a pound, which represents more than half of the total cost of dusting the cotton. Assuming that we dust four times in a season and use 5 lb. per acre at 10 cents a pound, the poison alone would cost $2. Adding $1.50 for application, the total expense per acre would be between $3 and $3.50. When it is realized that the average yield per acre is a third of a bale and that cotton has been selling for as low as $50 per bale, it is seen that the cost of applying the spray may represent a very considerable percentage of the selling price of the cotton. Dusting with arsenate of lime pays the farmer well if the control is successful and if the yield is a bale per acre or over, as it is in the heart of the Delta cotton belt. In the poorer sections, however, the situation is very different, and a planter who cannot hope for over a quarter of a bale per acre would really just about as soon have the boll weevil eat his cotton as have his profits go to the manufacturer of calcium arsenate. If the price of arsenate of lime could be cut in half, this would very naturally extend its application to the poorer fields. Likewise, when cotton is selling at a high price, the cotton planter can afford to buy calcium arsenate, when otherwise he could not. It is not a simple problem, but one which involves considerable guesswork as well as experience in the yield of the particular land which the planter is cultivating.

Another handicap to the development of the use of

calcium arsenate is the method of marketing the product, which has been both erratic and expensive. The product, being an agricultural spray material, has been handled along similar lines as other insecticides, the sale of which is largely a package proposition. Calcium arsenate is a spray material, but as a marketing proposition for boll weevil control it must ultimately be sold on a tonnage basis and the margin for sales expense and middleman profit must be reduced to the minimum permitted for fertilizers and similar products. Time will bring about this change in the natural course of events, and the State of Georgia in a way has forced the issue this season by purchasing direct from a manufacturer and distributing to the planter at cost.

The production of calcium arsenate must be classified at present as an "infant industry," but it is evident to any careful investigator of all phases of the situation that a demand for a great many thousand tons will develop in the next few years if the price is low enough.

Summary

For every hundred pounds of calcium arsenate which is made, approximately 40 lb. of white arsenic is necessary. The supply of white arsenic annually consumed by this product thus far is not large, but it is an appreciable percentage of the total supply, which, it must be remembered, is a relatively stationary quantity. The use of calcium arsenate for the boll weevil will increase, but at a rate which cannot be anticipated. It will depend upon the supply of arsenic which is available, upon the price of cotton, upon the yield of cotton per acre and upon the price of calcium arsenate itself. In addition, other uses of calcium arsenate are increasing from year to year, notably those which have to do with truck garden produce. Finally, calcium arsenate has been recently recommended as an effective means of preventing the alfalfa weevil from spreading. It is barely possible that this use may eclipse the use of calcium arsenate as a cotton insecticide. Other uses of white arsenic in various insecticides are also increasing, and these uses can easily outbid the cotton market for the available white arsenic. It will be seen, therefore, that many factors enter into the use of calcium arsenate as a cotton insecticide. Besides those already mentioned in this summary, we must refer to such things as the fashions for cotton fabric, the smelting of semi-precious metals, the education of the Southern darky and many others far afield from chemical engineering.

Lead Pigments Marketed in the United States in 1920 and 1921

The following table shows the quantity and value of lead pigments marketed in the United States in 1920 and 1921 as reported by producers to the United States Geological Survey.

LEAD PIGMENTS MARKETED IN THE UNITED STATES

	1920			1921		
		Value			Value	
	Short Tons	Total	Per Ton	Short Tons	Total	Per Ton
Sublimed lead:*						
White	12,412	$2,083,647	$167.87	11,568	$1,418,403	$122.61
Blue	928	153,657	165.58	463	58,593	126.55
Red lead	34,431	7,523,089	218.50	21,814	3,410,904	156.36
Orange mineral				379	91,184	240.59
Litharge	62,329	12,386,185	198.72	41,953	5,740,690	136.84
White lead:						
Dry	33,678	6,351,798	188.60	26,695	3,749,851	140.47
In oil	112,017	25,986,100	231.98	143,634	27,713,257	192.94

* Includes basic sulphate lead.

Petroleum Refineries in the United States

Of the total of 479 refineries, with a capacity of 2,109,700 bbl., reported by the U. S. Bureau of Mines as existing in the United States Jan. 1, 1922, 31 plants with a capacity of 759,000 bbl. were complete refineries representing 36 per cent of the total capacity, according to a compilation made by the American Petroleum Institute based on the data of the Bureau of Mines.

There were 251 skimming plants, with a capacity of 636,890 bbl., representing 30.2 per cent of the total capacity.

Skimming and lubricating plants numbered 56, with a capacity of 186,950 bbl., representing 8.9 per cent of the total capacity.

Wax plants numbered 51, with a capacity of 187,260 bbl., or 8.9 per cent of the total capacity.

There were 7 skimming and asphalt plants, with a capacity of 89,700 bbl., or 4.3 per cent of the total capacity.

There were 9 topping plants with a capacity of 68,800 bbl., representing 3.2 per cent of the total capacity.

Skimming, lubricating and asphalt plants numbered 3, with a capacity of 45,000 bbl., or 2.1 per cent of the total capacity.

There were 7 asphalt plants with a capacity of 33,850 bbl., or 1.6 per cent of the total capacity.

Lubricating plants totaled 12, with a capacity of 18,000 bbl., or 0.8 per cent of the total capacity.

Forty-seven plants with a capacity of 50,050 bbl., or 2.4 per cent of the total capacity, were unclassified.

The following table shows the capacity percentage rank of the various types of refineries as classified by the Bureau of Mines:

PETROLEUM REFINERIES IN THE UNITED STATES

	Total		
Kind of Plant	No.	Capacity Bbl.	Per Cent of Combined Capacity
Complete	31	759,000	36.0
Skimming	251	636,890	30.2
Skimming and lubricating	56	186,950	8.9
Skimming and asphalt	7	89,700	4.3
Skimming and coke	4	22,200	1.0
Skimming, lubricating and asphalt	3	45,000	2.1
Skimming, lubricating and coke	1	12,000	0.6
Wax	51	187,260	8.9
Lubricating	12	18,000	0.8
Asphalt	7	33,850	1.6
Topping	9	68,800	3.2
Unclassified	47	50,050	2.4
Total	479	2,109,700	100.0

An Exceptional Industrial Safety Record

Total elimination of accidents during 1921 without a minute lost time by workmen is the record established by the 124 employees of the H. H. Robertson Co. plant at Ambridge, Pa. Recognition of this unusual accomplishment was made at the fourth annual banquet of the Western Pennsylvania division, National Safety Council, through the presentation of the Rice Safety Award bronze tablet to the employees of the company. The award was accepted on behalf of the employees by W. E. Megraw, safety director.

This record is particularly interesting because in addition to the usual industrial hazards, employees are constantly unloading and handling steel sheets, coating them with asphaltic compounds heated to from 300 to 400 deg. often under severe fume conditions, moving the sheets and finished product from place to place and at times working on lines through which hot oils are piped.

Modern Methods of Concentrating Sulphuric Acid*

Methods in General Use and a Newly Developed Apparatus of the Submerged Hot Air Type With Particular Reference to Its Application in the Concentration of Separated Sludge Acid From Oil Refining

BY PETER S. GILCHRIST
Chemical Construction Company

CONSIDERABLE study of sulphuric acid concentration has been made by different chemical engineers during the last few years, stimulated, to some extent, by the heavy demand occasioned by the war. Instead of small units of 5 to 10 tons capacity per day, we now think of units of 80 to 125 tons capacity per day, the large units requiring no more labor than was required for the smaller units and, at the same time, operating with greater economy of fuel.

The advent of the Glover tower gave chemical engineers the idea of using the principle of the Glover tower for the higher concentration of acid. Today the tower system and the combined tower and surface evaporation systems of concentration are the methods in most general use, especially for concentrating chamber acid.

Owners of plants for the concentration of chamber acid, or the reclaiming of contaminated sulphuric acid, are today looking for equipment that will operate without too many unnecessary shutdowns for repairs, and that can be operated with the least possible labor.

The principal features to be considered when planning the installation of a concentrator are the following: A reasonable investment for the owner, durability of the equipment, minimum labor, low consumption of fuel and power, high recoveries and elimination of waste fumes.

The use of fuel oil as a heating medium for evaporation and the perfection of the oil burner so as to get absolute combustion have made it practical to apply the direct heating principle for evaporating, without discoloring or contaminating the acid.

The use of more permanent construction materials has reduced to a minimum the maintenance and labor costs. For instance, a vast amount of concentrating is now being done in baths by the direct-heating principle and in towers where the principal item of construction is acidproof masonry. The adoption of acidproof iron for overflows and transfer lines for hot strong acids has been very advantageous.

In this paper the antiquated pan, still and bottle systems are eliminated, confining the description to the following systems: (1) Cascade. (2) Tower system. (3) Combination surface evaporation and tower concentration. (4) Hot air submergence type. These four methods, especially the last three, are the ones used principally in modern plants.

DESCRIPTION OF CONTINUOUS CASCADE SYSTEM

In this type of concentrator we have the application of indirect heat for evaporation. The heat can be supplied with oil, gas, coal or coke. The combustion gases do not contaminate the acid, as the pans are heated from the under side, the hot gases not coming in direct contact with the acid. This type consists of a series of pans, or dishes, in several rows, each row a step higher than the preceding one in order that the acid may enter at the top pan and overflow by gravity from one pan or dish to the other until it is sufficiently concentrated. The heat is applied at the acid outlet end, at which place is located the lowest row of pans. The pans or dishes are supported on open seats which are directly exposed to the heat.

The three or four lowest dishes in each series are protected by bowls from the direct heat, so as to prevent violent ebullition and spurting of the acid. The acid vapors are drawn off by an exhauster and condensed. The loss by fumes is apt to be greater with this system than with the tower system. The cascade apparatus is designed so as to get at each dish or pan readily in case of breakage. A cracked or broken pan necessitates an interruption in the flow of acid, in addition to the loss of acid sustained. The advent of the vitreosil dish, which has a very low coefficient of expansion, has very materially reduced the losses by breakage. It is claimed that the breakage of vitreosil dishes is about 5 per cent and the pans 1 per cent. A. E. Wells and D. E. Fogg[1] described a 10-ton plant with one hundred dishes 12 in. in diameter and 60 preheating pans 24 x 12 in. for concentrating acid from 60 to 66 deg. Bé. They give the cost of concentration as follows:

Coal, 17 per cent at $5.00 per ton	$0.85
Labor	1.25
General expense and repairs	1.00
Losses, 4 per cent of acid, assuming 60 deg. Bé. acid at $8.00 per ton	.30
Operating cost per ton of 66 deg. Bé. from 60 deg. Bé.	$3.40

For comparison with other estimates following in this paper, it is to be noted that 17 per cent of a ton of coal, or 340 lb., is equivalent to 245½ lb. oil, or 32.3 gal. Then 32.3 gal. oil at 4c. per gal. equals $1.29, or an increase of 44c. in fuel cost per ton of acid, making the total cost on the basis of Wells' and Fogg's figures $3.84 per ton.

DESCRIPTION OF COMBINATION CASCADE AND TOWER SYSTEM

Combinations of cascade and tower systems have been used. An installation at Baltimore in 1916, with twelve iron pans 36 in. in diameter, in two rows, produced 23 tons of 66 deg. acid per 24 hours from 54 deg.

*A paper presented before the Acid Symposium at the fourteenth semi-annual meeting of the American Institute of Chemical Engineers, Niagara Falls, Canada, June 19 to 22, 1922.

[1] "The Manufacture of Sulphuric Acid in the United States," Bulletin 184, Department of the Interior, p. 137.

Bé., the acid entering the top pans being 57 deg. Bé. at 290 deg. F. Actual operating cost per ton of acid is as follows:

Fuel oil, 19.5 gal. at 4c.	$0.78
Labor	.71
General expenses and repairs	.85
Losses, 10 per cent of acid, assuming 60 deg. Bé. acid at $8.00 per ton	.80
Operating cost per ton of 66 deg. from 54 deg. Bé.	$3.14

Description of Tower System

In this type of concentrator the entire concentration is done in a tower. The tower is partly filled with suitable tower packing. The combustion gases enter at the bottom of the tower, and as they ascend they meet the downcoming acid in the tower, the exit of steam and gases being made at the top of the tower.

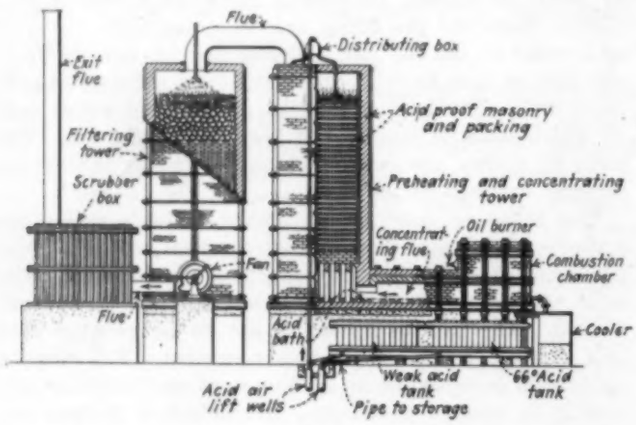


FIG. 1—COMBINATION SURFACE EVAPORATION AND TOWER TYPE FOR CONCENTRATING CHAMBER ACID

The weak acid is sprayed in at the top, and the strong acid settles in a basin at the foot of the tower. It is interesting to note that in this type of concentrator the entire volume of hot air comes in direct contact with the acid, thus keeping the strong acid at its actual boiling point. This has the disadvantage that the hot gases of combustion play directly on the arches and tower packing before the gases have much chance to cool.

The depreciation on the apparatus for this method of concentration is very reasonable, due to the tower being made of acidproof masonry work, but it is understood that the lower part of the packing has to be renewed occasionally, as it will burn out due to the high heat. Results from this method are claimed to be 1 ton of 66 deg. acid from 60 deg. with 11 to 12 gal. of oil.

Description of Combination Surface Evaporation and Tower System

It was found years ago that the method of surface evaporation, or direct heat application, was much more efficient than the indirect application of heat, such as with pan or still systems. Surface evaporation was not very practical before the advent of the oil burner, as absolute combustion is essential to success. The principle of tower concentration is well known. In this combination type concentration is accomplished (1) by surface evaporation, (2) by tower evaporation and preheating. The weak acid is sprayed in at the top of the tower. The upper portion of the tower does the preheating and the lower portion the preliminary concentration. The tower is packed with suitable packing materials. The acid falls from the tower into a long horizontal flue containing a bath of acid, over which the hot gases pass. The combustion gases enter the flue at the acid outlet end and pass along the surface of the acid to the foot of the tower, where they pass up through the interstices of the tower packing, meeting the downcoming weak acid. The tower is of sufficient height and size to utilize the remaining sensible heat of the combustion gases. The greater part of the concentration is done in the pan flue, where the acid is brought to maximum strength. The bath of acid is about 9 in. deep, and as the hot gases are brought into immediate contact with the surface acid, the acid takes up the heat much better than when the acid and heat are separated by metal plates, as is the case with cascade or pan systems. Evaporation is very greatly assisted by the direct heat over the acid, as the draft quickly removes the vapors formed. The finished acid leaves the concentrator at the furnace end, temperature about 50 deg. F. below the actual boiling of the acid, which is strong evidence of the efficiency of this system. Because of low heat reaching the tower, the apparatus itself has a very long life and the tower packing proper will last as long as any of the apparatus.

The principal apparatus of this concentrator consists of a combustion chamber, a concentrating pan flue, concentrating tower, filter and scrubbing tower, all of which are constructed of acidproof masonry, well braced with steel framing and supported on concrete or brick foundations at a suitable height above the ground level. On top of the concrete foundations, masonry-lined lead pans are used, on which are built the masonry walls. The concentrating tower is packed with checkered brick, quartz or other suitable packing, and the

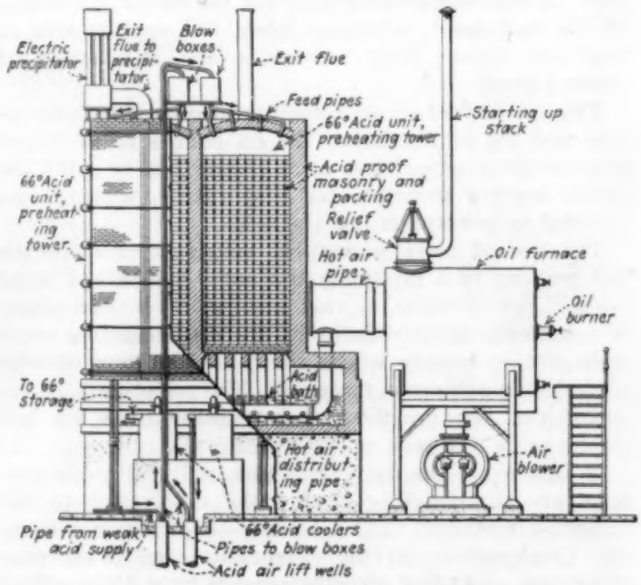


FIG. 2—HOT AIR-SUBMERGENCE TYPE UNIT FOR CONCENTRATING SLUDGE ACID FROM OIL REFINING

filter tower is packed with 3 in. special rings, or quartz. If the packing materials are carefully selected, the distillate from the tower can be sold for battery acid and other similar uses.

Two 50-ton units of this type concentrator were installed nearly 5 years ago at Bayonne, N. J., for the

Standard Oil Co. Recent figures have shown that over this protracted period of operation the consumption of oil was from 10 to 11 gal. per ton of 66 deg. acid starting from 55 deg. Bé. During a period of a little more than 4 years, over 140,000 tons of 66 deg. acid was turned out with a repair and upkeep cost of less than $10,000. This gives the cost of repairs and upkeep at 7c. to 8c. per ton of 66 deg. acid. One man per shift operates the entire plant. Cost of operation is as follows:

Fuel, 11 gal. at 4c.	$0.44
Labor	.12
General expenses and repairs	.30
Losses, 3½ per cent based on $8 per ton of 60 deg. acid	.28
Operating cost per ton of 66 deg. acid from 54 deg. Bé.	$1.14

The labor per ton for large plants is naturally less than for small plants.

This system of concentration is especially adaptable for making 98 per cent acid, on account of construction. The apparatus can easily withstand the higher temperatures encountered in the final stage of concentration. In bringing acid to 98 per cent strength, provision has to be made for taking care of the additional distillate, and naturally the output of acid decreases and the oil consumption increases.

Description of Hot Air Submergence System

Especially in the concentration of sludge acid it is necessary to accomplish concentration at the lowest possible temperature, because the acid to be concentrated is contaminated with carbonaceous matters which, in company with strong hot acid, quickly causes the breaking up of the acid into SO_2, it being well known that 1 lb. of carbon will break up 16 lb. of acid. Heretofore the pans have been used mostly for the concentration of sludge acid, but the cost is almost prohibitive, and in some cases when using the pan system the cost of concentration exceeded the cost of new acid. The cost of concentration by this new method of hot air submergence in some instances has reduced the cost of the 66 deg. recovered acid to one-third or one-fourth the cost of new acid.

This hot air submergence type of apparatus is designed to concentrate any kind of sulphuric acid, and especially separated sludge acid of any quality. The underlying principle of the process is concentration by blowing hot air, at a temperature of about 1,200 deg. F., through the acid. The process is continuous except that when handling sludge acid the concentration must be carried out in two stages for reasons stated later.

Operation of Submergence System on Sludge Acid

In concentrating sludge acid from oil refineries, the operation is carried out in two stages in order to avoid frothing and foaming due to the decomposition of the hydrocarbons. In the first stage operation the weak acid is fed in at the top of the tower direct from the pumping lines. The pumping and regulation of the acid are done entirely with the well-known acid air lifts. The rate of supply is carefully regulated to control the speed of operation, also the strength and temperature of the acid bath in the concentrator. By controlling the temperature and the quantity of air blown through the acid and the amount of acid fed to the concentrator, the acid in the pan is maintained constantly at from 50 to 55 deg. Bé., or just below the point at which foaming commences. At this strength the acid hydrocarbons are broken down and volatilized by the rapid stream of air passing through the acid. The acid remains constantly at a strength sufficiently low so that carbonaceous matters (tar, oil, etc.,) are not attacked, and consequently the losses in the first unit are practically negligible. The acid is drained off continuously, passing through a cooler into intermediate storage tanks, from which it is pumped to the top of the high stage unit for the second stage operation. The operation of the high stage unit is very similar to that of the low stage unit. The acid bath is maintained at 66 deg. Bé. and is drawn off continuously at that strength. The finished acid comes out of the concentrator at about 110 deg. F. below its actual boiling point.

Each unit is provided with a tower packed with checkered brick which serves principally as a preheater.

The hot air is produced by the combustion of oil in a specially designed combustion furnace which operates under pressure. A blower provides air sufficient for combustion and an excess necessary for the proper regulation of the temperature. The hot air from the combustion chamber passes through a main header to both units and is distributed through manifolds to a point below the acid level in the concentrator bath.

When the air at 1,200 deg. F. is released under the surface of the acid, it quickly gives up its heat and passes out of the bath at a temperature slightly higher than the temperature of the acid. It gives up most of its remaining heat in passing through the preheating tower.

The two units in which the first and second stages of concentration are carried out are of similar construction. The acid bath is contained in a rectangular lead pan on a raised concrete foundation, the pan being lined with acidproof brick. About two-thirds of the pan is covered with a chemical brick arch, through which project the acidproof iron pipes that carry the hot air under the surface of the acid. A tower of acidproof masonry rises from the rear end of the pan to a height of about 30 ft. This tower is packed with staggered brick and provides sufficient surface for the transfer of the heat from the escaping gases to the incoming acid.

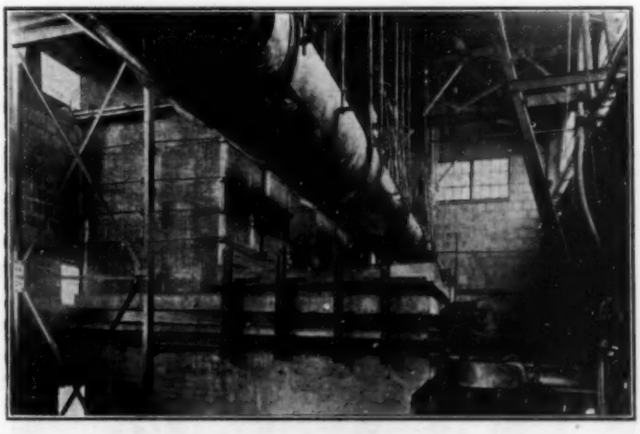


FIG. 3—SEPARATED SLUDGE ACID CONCENTRATING PLANT IN OPERATION

The results over a protracted period of operation

have shown the oil consumption to be around 35 gal. per ton of 66 deg. Bé. acid when starting from acid of 35 deg. Bé. at room temperature. This oil consumption figure includes raising the heat of the acid in the second stage operation. This gives an equivalent of about 9½ to 10 gal. of oil per ton of 66 deg. Bé. acid when starting from 60 deg. Bé. In the lead pan system, besides the expense incurred by frequent repairs to the pans, it has been recorded that it requires 90 to 110 gal. of fuel to concentrate 1 ton of 66 deg. acid when starting from 35 deg. Bé.

One man per shift can operate the largest plant in existence, and the maintenance cost has proved to be around 30c. per ton of 66 deg. acid.

Comparative cost of concentrating sludge acid by the old and new method is as follows:

Cost of Producing 66 Deg. Acid From 35 Deg. Bé. Sludge Acid Using Lead Pans and C. I. Stills

100 gal. oil at 4c.	$4.00
Labor	.60
General expenses and repairs	2.50
Losses, 20 per cent based on $8 per ton of 60 deg. acid	1.60
Operating cost per ton 66 deg. acid from 35 deg. Bé.	$8.70

Cost of Producing 66 Deg. Acid From 35 Deg. Bé. Sludge Acid Using Hot Air Submergence Type

35 gal. oil at 4c.	$1.40
Labor	.20
General expenses and repairs	1.10
Losses, 6 per cent based on $8.00 per ton 60 deg. acid	.48
Royalty	1.00
Operating cost per ton 66 deg. acid from 35 deg. Bé.	$4.18

Sulphuric Acid Gas Recovery

The method of recovering gases has not been touched upon. This is interesting, because the fume trouble has always been an important subject for lawsuits.

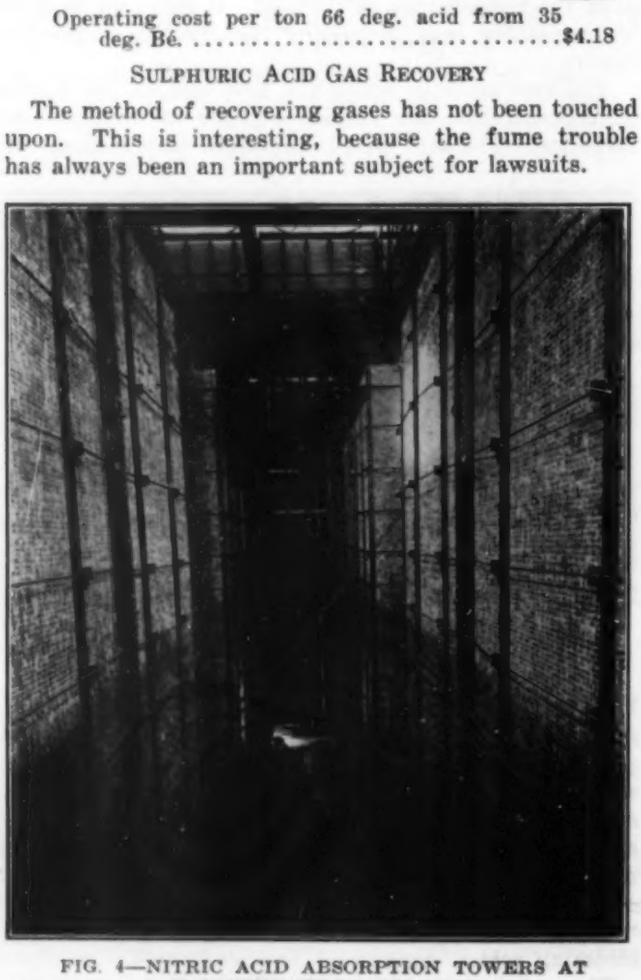


FIG. 4—NITRIC ACID ABSORPTION TOWERS AT U. S. NITRATE PLANT NO. 2

In the indirect method of concentration, the escaping gases may be efficiently condensed in water-cooled condensers, but when concentrating by the direct heat method, the escaping gases are of greater volume, for which reason such condensers are impracticable. In general practice a filtering or scrubbing tower is used. These generally consist of towers or large boxes constructed of lead or acidproof masonry, packed with suitable tower filling, such as coke, hard coal, quartz or rings. If the filtering area, or the tower filling, is of large enough volume, and if the filling material itself is efficient, water is not required. In cases where the filtering area is small, the gases will be absorbed more efficiently by spraying a little water in at the top of the tower. When using water for filtering, in some cases the strength of the distillate acid varies from 30 to 40 deg. Bé. In efficient towers the condensed acid varies in strength from 40 to 55 deg. Bé. when no water is used.

The electric precipitator is being used exclusively for the precipitation of the acid gases in conjunction with hot air submergence type concentrators, whether used for concentrating chamber acid, sludge acid or other contaminated acids. It has also been found very effective on other installations. It looks as if this precipitator will eventually replace all other gas-filtering methods, as the construction is very simple, the recovery the most perfect and the cost of operation very little. The acid comes out of the precipitator at from 50 to 60 deg. strength and the recovery in several instances has been recorded at 99 per cent, while the recovery in filtering towers varies from 60 per cent to 95 per cent.

Acidproof Masonry

The use of acidproof masonry as a permanent construction material for concentrators has been mentioned several times. The success of this construction for concentrators and for all other kinds of acid absorption and treating towers is assured. The construction requires careful design, the use of superior and proper grades of material, the best workmanship and the proper curing and treating of the cement, especially in the hot towers for sulphuric acid. The outer walls are constructed of acidproof shale brick and acidproof cement, and the inside of tower is lined with several layers of 1-in. chemical tile. Towers thus constructed are very durable and if the work is properly done and the towers properly treated, very little seepage will take place. All masonry towers should be operated under slight vacuum.

Several makes of cement have been used—for example, "Acipruf" as manufactured by the Chemical Construction Co., and "Duro" as used by the Process Engineering Co. In these cements, sodium silicate is used as a binder.

The largest example of acidproof masonry work in this country is the installation of the nitric-acid absorption towers and acid concentrators at government nitrate plants at Sheffield and Muscle Shoals. In both places combined there were fourteen large towers, each measuring 32 ft. square on the outside and 60 ft. high, each tower being divided into four parts and each part packed in its entirety with "Chemico" spiral packing rings. In these installations it required millions of brick and several thousand tons of "Acipruf" cement. During the operating test period of these towers, no leakage whatever developed.

Preparation of Metal for Microscopic Examination

FROM LABORATORY NOTES BY
WILLIAM CAMPBELL
Professor of Metallurgy, Columbia University

PREPARATION OF SPECIMENS

FOR microscopic examination it is necessary to have a flat surface free from all scratches and possessing a high degree of polish. To attain this, various methods may be followed, depending on the nature of the specimen and the polishing equipment available.

For ordinary material, the most convenient size of specimen is from ½ to 1 in. square and ¼ to ⅜ in. thick. Larger specimens are increasingly difficult to handle.

Brittle and hard material may be broken with a hammer or cut with an emery disk well flooded with water to prevent heating. It is then ground down flat on an emery wheel of No. 60 grade or slightly coarser. Extremely brittle material will not stand the emery wheel and has to be taken down on a lap or a flat glass plate using carborundum powder of about FFF grade.

Normally tough material is cut to size with a power hacksaw. A flat surface is then obtained by using "smooth" and "dead smooth" files, rubbing the specimen on the file, which is held on the jaws of a vise. Steel and cast iron may be ground free from hacksaw marks on the emery wheels.

Material of small size has to be mounted. For wire or sheet a convenient method is to hold the specimen in a clamp built up of two brass plates, 1 in. x ½ in. and ⅛ in. thick, held together by two screws. A layer of red fiberboard or Bakelite is placed between the brass plates and the specimen. For thin wires, a mount can be made of fusible metal or "gum-lac," set in a brass container.

Having obtained a smooth surface of workable size, the next step is to get as fine a surface as possible preliminary to the final polishing with rouge or alumina. With mechanical polishing this can be done on finer grades of emery wheels (No. 100 and 200), or disks covered with strong, fine canvas and armed with carborundum or alundum powders of progressively finer grades. The number of grades necessary depend on the nature of the specimen. Disks should run horizontally.

With hand polishing the specimen is rubbed on the following grades of emery paper:

1. Rough—Commercial No. 0
2. Smooth—Commercial No. 00
3. French—Hubert No. 0
4. French—Hubert No. 00
5. French—Hubert No. 000

The specimen is first rubbed on the rough paper perpendicular to the direction of the file marks or emery wheel scratches until all of these have disappeared. The specimen is then dusted and wiped free from all grit and rubbed on the smooth paper, the new scratches being 90 deg. to those of the last paper, and so on through the series. All scratches from the previous paper must be taken out before passing to the next. Grits from one paper must never get onto the next, or the specimen will be spoiled.

Final polish is given with well-washed rouge or alumina. With hand polishing a block of wood, 12 x 6 in., is covered with broadcloth stretched tight. It is covered with well-moistened rouge or alumina, conveniently kept in a wash bottle containing 1 part rouge to about 5 parts of water. The specimen is given a circular motion to avoid pitting. When mechanical polishing is used, the disk is covered with broadcloth and armed with rouge or alumina as above, and runs horizontally at not over 500 r.p.m. If a higher speed is used, the polishing material is thrown off the wheel unnecessarily. If the disk revolves vertically, much polishing material is thrown off even at lower speed. In all this kind of polishing the specimens must be revolved round and round the wheel or pitting results, due to a scouring action in the softer spots.

The above methods hold good for iron, steel, cast iron, brass, bronze, or bearing metals. However, very soft alloys, such as the solders or any alloy with a large porportion of lead, must be polished with great care, or the surface of the metal actually flows like molasses, and the true structure is masked. The later etching does not serve to get rid of this difficulty.

When the final polish is finished, wash well under the tap, dry with alcohol and mop or pat the surface with a soft rag. This must be done immediately, or the specimen will oxidize. Do not rub the specimen in any way, or the surface is likely to be spoiled.

Now examine the specimen under the microscope and note any colored constituents, such as slag in wrought iron, oxide, manganese sulphide and silicate in steel, graphite in cast iron, temper carbon in malleable cast iron; oxides or sulphides in copper and its alloys, and so forth. Flaws and cracks in faulty material are to be noted. Shrinkage cavities show up.

In the preparation of specimens the object is to learn the true structure of the material. In many cases this varies with the location of the specimen. In cast material, sections should be cut perpendicular to the cooling surface, from the outside to the center of the ingot or casting. In rolled or forged material the sections should be parallel to the direction of rolling or forging, for a cross-section alone is often misleading.

DEVELOPMENT OF STRUCTURE

The usual method is by etching. Care must be taken to avoid overetching or the specimen must be repolished. The etching material varies with the specimen, as follows:

Wrought Iron. Etch with 5 per cent picric acid in alcohol. The surface of the specimen is covered with the solution on a container, which is rocked slightly to get uniform action. When the picric acid has become very dark, say after 1 minute, the specimen is washed under the tap, and dried with alcohol. This will show up any pearlite present. In order to develop the grains of the ferrite, the specimen is re-etched by immersing in picric acid for 5 minutes. This can also be done by etching in 2 per cent solution of nitric acid in water for 5 seconds, but the picric acid is safer, since there is not the same liability to overetch. Furthermore, nitric acid eats into the iron very deeply around the slag areas and also pits very deeply.

Steel. Etch with picric acid, as above. Pearlite is attacked and turns brown to blue-black. Ferrite and cementite are not attacked. Steels with carbon content in the neighborhood of the eutectoid (0.9 per cent C), possess a structure in which it is often difficult to distinguish between ferrite and cementite when the excess constituent occurs in very thin envelopes. They may easily be distinguished by boiling in a solution of picrate of soda which turns Fe_3C black, but leaves ferrite bright white. The carbon content of pearlite varies

with the rate of cooling and the percentage of manganese present. In ordinary rolled material (bessemer or open hearth) we can assume:

0 to 10 per cent	pearlite.	C in pearlite	= 0.9 per cent
10 to 25 per cent	"	" " "	= 0.85 per cent
33 per cent	"	" " "	= 0.80 per cent
50 per cent	"	" " "	= 0.75 per cent
66 per cent	"	" " "	= 0.70 per cent
75 per cent	"	" " "	= 0.65 per cent
90 to 100 per cent	"	" " "	= 0.60 per cent

With very thin sections, containing from 90 to 100 per cent pearlite and analyzing 1 per cent manganese, the carbon content of pearlite is nearer 0.55 per cent than 0.60 per cent.

Cast Irons. Etch with picric acid. Cementite is likely to be stained before all of the pearlite is developed in certain high-silicon irons showing the "cementite" eutectic as a network more or less discontinuous, surrounding grains containing ferrite, etc. A light etch with 2 per cent nitric acid will often differentiate between the ferrite high in silicon (silico-ferrite) and the pearlite, and still leave the cementite eutectic bright.

Copper Alloys. Pure copper, sheet bronze, cast brass, german silver, etc.: Etch with ammonia and peroxide as described for gunmetal. Ferric chloride, ammonium persulphate and 50 per cent nitric acid have been advocated. Nitric acid etches rather deeply for photographic work, but is better for general work than the other two, but less desirable than ammonia and peroxide.

Gunmetal, Bell Metal, Cast Bronze. When these are etched with 50 per cent nitric acid (1 part concentrated acid to 1 part water) the dendritic structure shows up well, but the eutectoid is darkened and its structure obliterated. A much better method is to use 5 c.c. ammonia with a few drops of hydrogen peroxide and apply it by rubbing with a small wad of absorbent cotton until the structure appears quite clear to the eye. Fresh solutions should be made up in a watch glass for each specimen. By this means the copper-rich cores of the dendrites are deeply attacked while the eutectoid remains quite bright. The eutectoid can be made to show up in strong contrast by flooding the etched specimen with Grard's solution[1] until the color begins to change, and then quickly washing off the liquid reagent under the tap.

Sheet Brass. The structure is best developed by using ammonia with a few drops of hydrogen peroxide, as demonstrated by the wonderful photographs of Mathewson, Bassett and their associates.

Monel Metal. As cast, the structure is best developed by a mixture of dilute acetic and nitric acids. The wrought metal when in the annealed condition can also be etched with Grard's solution, which shows up the grains alternately light and dark. When Monel metal is etched with 50 per cent nitric acid it tends to pit badly, these pits starting with tiny dots of oxide as nuclei. The resulting structure is therefore very badly pitted.

Bearing Metals. For white metals in general use 2 per cent HNO_3 in water or alcohol. Great care must be taken not to overetch the specimen, especially those with a zinc base. Those with a lead or tin base are not so easily overetched and, with care, a 10 per cent HNO_3 in water can be used.

[1]Made of 5 g. ferric chloride, 50 c.c. hydrochloric acid and 100 c.c. water.

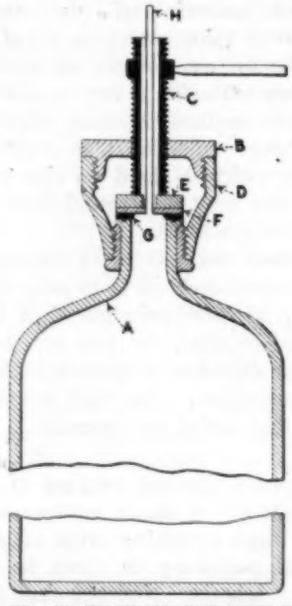
A Simple Type of Glass Pressure Bottle*

By R. R. Reed

Editor's Note—It is not our custom to publish articles dealing with laboratory apparatus, but the possible use of this ingenious device in development work and in tests on manufacturing processes makes it of considerable interest to technical men.

A REQUISITE for every chemical laboratory is a glass pressure bottle, in which reactions between corrosive reagents requiring moderate temperatures and pressures may be carried out. Such a bottle with a capacity of 800 c.c. can be constructed from readily available materials at moderate cost.

The top of a soda-water siphon *A* (the ordinary seltzer bottle) is ground flat on a wet stone and a narrow, shallow groove cut concentrically by means of emery and a metal tube rotated in a lathe, the groove assisting materially in preventing any leakage.



GLASS PRESSURE BOTTLE

The top is constructed of pipe fittings: a reducing coupling *D*; a reducing plug *B*; a short length of ½-in. pipe threaded from the ends so that a T may be screwed down one-third the length of the pipe; an iron disk *E* with a ⅜-in. hole; a lead disk *F*, and an asbestos disk *G*. A very thin platinum foil gasket may be placed between the asbestos and the bottle if necessary.

The top is attached by means of the split, threaded fitting which serves the same purpose in the original bottle. Closing of the bottle is effected by careful application of pressure by means of *C*.

When it is desirable to ascertain the pressure in the bottle, a manometer, made of capillary tubing closed at one end, is attached by means of a ¼-in. copper tube *H*, which extends down through *C*, *E* and *F*, to which latter it is soldered. By this means pressures up to 150 lb. per sq.in. (the limit of safety) may be measured.

Due to the thickness of the glass, heating must be carried out very slowly in a water, salt or oil bath, otherwise breakage is sure to result. In general a rise in temperature to 100 deg. should take about 1 hour. These bottles will stand 150 lb. per sq.in. pressure, but precautions against explosion should always be taken.

*Contribution from the department of chemistry, Yale University.

Corrosion of Iron and Steel—Influence of Molecular Concentration on Immersion-Test Investigations

Initial Rate of Corrosion the Most Important, Since Solution Rates Change as Equilibrium Approaches —Spent Solutions Often Harmless, but Sometimes Accelerate Corrosion—Short Tests in Circulating Pure Chemicals the Logical Method for Comparative Tests

BY D. M. STRICKLAND
Research Engineer, American Rolling Mill Co., Middletown, Ohio

SCIENTIFIC experiments which yield constructive information relative to the various phases of iron and steel corrosion command the attention, not only of investigators, but also of architects, contractors, engineers of tests, civil and highway engineers and all other extensive users of ferrous metals.

Tests in which uncoated sheet metals are exposed to atmospheric conditions yield results which may be of little commercial value, because the conditions of such tests simulate but a limited class of daily service requirements. It is very seldom that uncoated material is chosen for sheet metal installations, the general practice being to protect the sheets with paint, spelter, tin or lead coatings. When uncoated sheets are used for testing purposes the formation of oxide coating introduces into the test a condition not found in actual service. In everyday usage, iron and steels are usually subjected to service requirements far different than the conditions which influence an atmospheric test. This is true for all underground constructions, boilers, tanks, railroad equipment, flumes, culverts and drainage constructions in general. In fact, there are few ferrous metal installations which are not subjected to partial, intermittent or total immersion conditions.

Endeavoring to devise test methods which more nearly approach such conditions of commercial requirements, chemists and metallurgists both at home and abroad have rightly turned to immersion-test investigations in order to obtain reliable data concerning the service life of iron and steel. The supervision of fresh water, salt water and mine water immersion investigations by the American Society for Testing Materials shows that the members of this society recognize the importance of immersion tests.

Laboratory immersion tests when properly conducted are valuable indicators of the performance of ferrous metals, but valuable as such investigations may be, if they are not conducted under conditions of recognized and standardized uniformity, the results are of no value. The importance of uniformity of testing conditions cannot be overestimated, as the non-conclusive and even misleading interpretations which follow an unscientific investigation obscure the solution of any corrosion problem.

The purpose of this paper is to show the reliability of immersion tests when carefully conducted, not only by pointing out the necessity of properly interpreting the influence of solution molecular concentration but also by describing an immersion-test method where the variations in solution strength are reduced to a minimum and one which will be extremely valuable in establishing the immersion test as the most reliable of present day testing procedures.

Immersion tests require close attention and study. Before starting, the investigator must consider carefully the nature of the chemical actions which occur. One must understand not only the influence of temperature changes but also the influence of such variable molecular concentrations as result from unequal evaporation or exhaustion of solution.

CHEMICAL CHANGES DURING CORROSION

Corrosion is a chemical change and the reaction conforms to the chemical reaction laws. As the metal reacts with the corroding liquid it is possible that

First, the reaction is irreversible, and an insoluble precipitate forms or a gas is evolved.

Second, a chemical equilibrium is established, characterized by the usual phenomena of the reversible reaction.

Third, byproducts of the reaction in turn attack the metal, inducing a secondary reaction, which in some instances accelerates the corrosion and in other cases retards the primary action.

Usually corrosion reactions are of the first class and irreversible. However, regardless of the type of reaction, at any given moment of time the speed of the chemical action depends directly upon the molecular concentration of the solution surrounding the metal samples. Generally the speed of the reaction approaches zero as the chemical approaches exhaustion or as the pending chemical equilibrium approaches a balance.

It must be remembered that chemical action begins the moment the specimens are brought in contact with the corroding solution. Since the rates of corrosion of the various grades of metals differ, the test conditions quickly lose their uniformity, since the relative resistivity of the metals to the chemical change involved determines the molecular concentration of the solution and this condition governs the reaction speeds.

It is obvious that when this complex variable is considered, true conclusions will be derived from the test data. The various theoretical factors which contribute to variations of molecular concentration may be of little interest to many investigators, but when they realize that such a variable exists and continuously changes the speeds of corrosion even in tests where all other conditions are uniform, their experiments will yield results of great value.

Consider an immersion test where specimens are immersed in equal volumes of a 10 per cent solution of S. An iron or steel reacting rapidly will be surrounded at

the end of *T* hours by a solution of molecular concentration differing in marked degree from the liquid surrounding test-pieces which reacted at a slower rate. Such a condition usually favors the less resistant metal, as the speed of its corrosion is perceptibly lessened. As the test progresses, some particular grade of material will finally exhaust its solution strength. The action ceases. Unless the solution is then fortified with additional corroding medium or the entire test is discontinued, the iron or steel specimens which have been slightly attacked will continue corroding until in time they catch up with the worst sample. When cleaned and weighed, it will be found that the weight losses are practically equalized and the metal which in reality exhausted its solution first is erroneously deemed to have an equal corrosion-resistance value as metals actually far superior. The following résumé of tests conducted to determine the influence of variable solution strengths are interesting, as they bear out in practice the foregoing statements.

Description of Test Methods

A brief description of test methods will be of interest: Black sheets of 16-gage commercially pure iron made in open-hearth furnaces, coppered iron, common steel and coppered steel[1] were cut into 2x2-in. squares and carefully pickled. They were free from scale, rust, dirt, mechanical injuries, surface irregularities, excessively deep stencil marks, etc. All tests were conducted at room temperature, and any tendency toward unequal evaporation was eliminated. All experiments were run in duplicate and the figures reported are the averages of closely agreeing weight losses. All weighings were checked and the chosen time intervals were accurately followed. The samples were placed vertically in separate tumblers and completely immersed in equal solution volumes.

With such uniform initial conditions, the results obtained in the various corroding media will be influenced by two factors only:

First, the differences existing between the metals under test—that is, their various corrosion resistivities; due in turn to differences in homogeneity, uniformity, chemical purity, surface condition and other factors.

Second, the molecular concentration of the corroding solution.

Loss in Hydrochloric Acid

Test-pieces were immersed in 250 c.c. of 3 per cent hydrochloric acid. One set of samples was weighed at the end of 48 hours; the others remained in the solution for 30 days. Following is a comparison of weight losses expressed in ounces per square foot of actual surface:[2]

Material	End of 48 Hours	End of 30 Days
Commercially pure iron	0.08	4.31
Coppered iron	0.26	4.08
Common steel	0.29	4.20
Coppered steel	0.52	4.13

It would be erroneous to assume from the 30-day data that all metals were equally resistant to the corrosion reaction. The short-time test shows that the commercially pure iron is most resistant to the action of the hydrochloric acid. It is obvious that the various reaction speeds varied as the solution strength weakened. The rapidly corroding coppered steel soon so weakened the acid strength that the action slowed down. Between 48 hours and 30 days the action was so slow that the more resistant metals caught up and yielded equalized weight losses.

In actual service conditions, the corroding medium is generally in excess to the ferrous metals. It is the metal which fails and not the corroding medium which is exhausted. If, in everyday service, metal is in contact with hydrochloric acid, the acid strength would not weaken perceptibly, since it doubtless would circulate. The more rapidly dissolving metal has no opportunity to weaken the corroding medium or slow down in action. Instead, it will continue its rapid corrosion and fail quickly. Thus it is that a short-time immersion test closely approximates the working conditions.

Other samples were immersed in 300 c.c. of concentrated hydrochloric acid (38 per cent). At intervals of 30 minutes the samples were removed, dried, weighed and again immersed in *fresh* acid. Weight losses were determined from time to time with results as shown in Table I.

TABLE I—REPEATED IMMERSIONS IN FRESH CONCENTRATED HCl

Material	End of 5 ½-Hr. Periods	End of 15 ½-Hr. Periods	End of 20 ½-Hr. Periods	End of 30 ½-Hr. Periods
Commercially pure iron	0.14	0.50	0.66	0.75
Coppered iron	0.74	2.62	3.56	5.63
Common steel	1.65	5.25	6.93	10.29
Coppered steel	1.08	3.68	4.28	7.21

These figures verify results obtained by Dr. A. S. Cushman[3] as embodied in his paper wherein he describes the action of 38 per cent hydrochloric acid on pickled galvanized 2x3-in., 26-gage specimens.

TABLE II—REPEATED IMMERSIONS IN FRESH 20 PER CENT HC

Material	End of 5 1-Hr. Periods	End of 10 1-Hr. Periods	End of 20 1-Hr. Periods
Commercially pure iron	0.02	0.05	0.08
Coppered iron	0.03	0.08	0.12
Common steel	0.15	0.31	0.44
Coppered steel	0.04	0.10	0.17

Again, using 20 per cent hydrochloric acid solution and immersing samples in fresh solution every hour, the losses in weight obtained, expressed in ounces per square foot actual surface, are given in Table II.

Loss in Sulphuric Acid

Similar test-pieces were subjected to the action of 200 c.c. of 5 per cent sulphuric acid. The samples were removed from time to time, weighed and re-immersed in the same acid. The results are given in Table III.

TABLE III—REPEATED IMMERSIONS IN THE SAME 5 PER CENT H_2SO_4

Material	24 Hr.	48 Hr.	192 Hr.	40 Days
Commercially pure iron	0.09	0.16	0.93	4.25
Coppered iron	0.02	0.08	0.17	4.18
Common steel	0.28	0.38	1.77	4.20
Coppered steel	0.07	0.15	0.42	4.15

These results again show that if the test is undisturbed for a sufficient length of time the weight loss will

[1] Average analyses of the various materials:

Material	S	P	C	Mn	Cu
Commercially pure iron	0.020	0.005	0.010	0.009	0.020
Coppered iron	0.028	0.006	0.010	0.015	0.204
Common steel	0.020	0.012	0.090	0.273	0.034
Coppered steel	0.025	0.011	0.110	0.420	0.235

[2] All weight losses are reported as ounces per square foot actual surface. To convert to grams per square meter actual surface, multiply the reported figures by 305. A piece of 16-gage, having one square meter actual surface, weights 6,100 grams; one square foot weighs 20 ounces.

[3] "Notes on Some Anomalies Encountered in a Study of Immersion Tests of Iron and Steel," by A. S. Cushman and G. W. Coggeshall, American Electrochemical Society, 1921.

approach equality. The weight loss of each grade increases with time until the strength of the solution is weakened to such an extent that the speed of corrosion diminishes. For example, at the end of 192 hours the common steel lost 1.77 oz. per sq. ft., whereas at the end of 40 days this metal (instead of corroding at the same rate for a total loss of 8.85 oz. per square foot) had lost only 4.20 due to the fact that a weakening solution had retarded the corrosion reaction.

Loss in Nitric Acid

Using a 5-hour time interval between solution changes, similar test-pieces were immersed in 300 c.c. of concentrated nitric acid (70 per cent), with results as shown in Table IV.

TABLE IV—REIMMERSED IN FRESH 70 PER CENT HNO_3 EVERY 5 HOURS

Material	End of Total Immersion of 120 Hr.	End of Total Immersion of 240 Hr.
Commercially pure iron	0.09	0.17
Coppered iron	0.70	1.42
Common steel	0.23	0.48
Coppered steel	0.21	0.46

Had this test continued to the exhaustion of the reacting metals or corroding medium, figures would have been obtained which would be without value. This test is all the more interesting in that iron and steel is generally understood to be passive when in contact with cold concentrated nitric acid, whereas in this instance sufficient weight losses were obtained in 10 days to indicate accurately the greater resistivity of the commercially pure iron.

Loss in Aluminum Sulphate

Two separate tests were conducted in beakers containing 250 c.c. of 20 per cent anhydrous aluminum sulphate. One was permitted to continue until all specimens had exhausted their solutions. It required 1,500 hours for the commercially pure iron to reach this point, at which time the test was discontinued. Test-pieces used in the second test were all removed from the liquid after 296 hours when the most corodible metal had exhausted its solution. Table V shows the results.

TABLE V—CORROSION IN ALUMINUM SULPHATE

Material	End of 1,500 Hr.	End of 296 Hr.
Commercially pure iron	6.73	0.066
Coppered iron	6.80	0.138
Common steel	7.00	1.106
Coppered steel	7.00	5.113

It would be unjust to assume anything from the results obtained in 1,500 hours. The short-time tests shows that the coppered steel lost eighty times as much metal as did the commercially pure iron. This test is interesting in that it gives a striking example of relative initial resistivity.

Although it requires increased attention, investigators who remove all the samples at regular time intervals and again immerse them in full-strength solutions are conducting their tests in a manner closely approximating usual commercial requirements. As a rule, the shorter the time interval between solution changes the nearer will test conditions approach actual service conditions where the corroding medium is changing continuously. It would be poor practice to fortify from time to time all the solutions by adding equal volumes of the corroding medium. This would increase the complexity rather than simplify the problem of solution changes, as such practice would certainly concentrate solutions to variable extents, depending upon the relative amount of depletion occurring up to that time.

Loss in Ferric Chloride

In this experiment several groups of samples were immersed in 200 c.c. of 3 per cent ferric chloride and permitted to remain for various periods of time. At the end of each time interval the corroding medium was discarded and, after cleaning and weighing, the test-pieces were immersed in freshly prepared 3 per cent ferric chloride. The results, expressed in loss of weight in ounces per square foot of actual surface are summarized in Table VI.

TABLE VI—CORROSION BY PERIODICALLY RENEWED FERRIC CHLORIDE (3 PER CENT)

24-Hour Periods

Material	First 24 Hr.	Second 24 Hr.	Total 48 Hr.	Third 24 Hr.	Total 72 Hr.	Fourth 24 Hr.	Total 96 Hr.
Commercially pure iron	0.22	0.29	0.51	0.31	0.82	0.29	1.11
Coppered iron	0.24	0.30	0.54	0.33	0.87	0.31	1.18
Common steel	0.27	0.30	0.57	0.32	0.89	0.30	1.19
Coppered steel	0.27	0.32	0.59	0.33	0.92	0.31	1.23

48-Hour Periods

Material	First 48 Hr.	Second 48 Hr.	Total 96 Hr.
Commercially pure iron	0.36	0.35	0.71
Coppered iron	0.37	0.35	0.72
Common steel	0.37	0.35	0.72
Coppered steel	0.39	0.37	0.78

96-Hour Periods

Material	First 96 Hr.	Second 96 Hr.	Total 192 Hr.
Commercially pure iron	0.39	0.43	0.82
Coppered iron	0.41	0.43	0.84
Common steel	0.41	0.45	0.86
Coppered steel	0.40	0.55	0.95

192 Hour-Periods

Material	First 192 Hr.
Commercially pure iron	0.38
Coppered iron	0.42
Common steel	0.43
Coppered steel	0.57

240-Hour Periods

Material	First 240-Hr.	Second 240 Hr.	Total 480 Hr.
Commercially pure iron	0.47	0.38	0.85
Coppered iron	0.51	0.45	0.96
Common steel	0.49	0.36	0.85
Coppered steel	0.48	0.48	0.96

Table VI shows clearly how weight losses are absolutely dependent on the solution strength. The weight losses for each 24-hour interval agree closely. Even though the weight loss for a single 48-hour period is approximately 20 per cent greater than for a 24-hour period, yet the significant fact remains that the losses at the end of two 48-hour periods are much less than the weight losses recorded for three 24-hour periods. In fact, at the completion of four 24-hour periods figures were obtained which were greater than those recorded for any other time interval or combination of time intervals, including the two 10-day periods.

Investigators should determine before starting their immersion tests what time intervals should elapse between solution changes. Differences in losses between samples immersed for variable time periods will be noticeable regardless of the time intervals chosen, providing the shortest interval is not longer than the time required for equalization. Notice the ferric chloride weight losses for the 192-hour and 240-hour periods. Here we have average losses of 0.45 and 0.49 oz. per square foot, showing that these time periods are both too long to be used if reliable data are desired. It is probable that at the end of 96 hours an even greater variation in total corrosion would have resulted had 12-hour instead of 24-hour periods been used.

It will be noted that the various experiments described in this paper have corrosion reactions which are so rapid that it is only necessary for a few hours to elapse before confirming evidence is obtained showing that molecular concentration is an important variable in immersion tests. Although it would require many months to duplicate the evidence for slow reactions, nevertheless similar data would be the result of the longer investigation. This is because corrosion is a chemical change and the reactions involved conform to reaction laws. Consequently, if the corroding medium plays a direct part (no matter how slight or slow reacting), it must follow that the molecular concentration changes and reaction speeds vary, even though long periods of time may elapse before the influence is detectible.

It is possible that the corroding medium exerts only an indirect influence. The character of the reaction may be such that as the chemical in solution reacts with the ferrous metals the byproducts interact to the replenishment of this chemical. The solution may act as a catalytic agent, a carrier of necessary oxygen, an intensifier of electrolytic action, or in some other capacity where the corroding medium is seemingly unchanged. An investigator will study such complex reactions and use all the greater care to insure uniform test conditions. Unequal evaporation or water additions give a conductivity variable to electrolytes; variable air supply changes uniformity in tests requiring oxygen. There are a multitude of factors which influence tests where the functions of the corroding media are indirect; conclusions drawn from such investigations will indeed be valuable when due care is given to these variables.

Loss in Ammonium Persulphate

The solution used in this experiment was 10 per cent crystalline ammonium persulphate and it was conducted in the same manner as described immediately above for ferric chloride. See Table VII.

It is apparent that the figures in Table VII are comparable with results reported for the ferric chloride tests. After the samples had been immersed for four 24-hour periods, the resulting losses are again far greater than any other figures obtained. The losses after a 50-day immersion period were less than for two 24-hour intervals. It is conservative to say that during the 50-day period all samples lay idle in an exhausted solution for about 45 days.

TABLE VII—CORROSION BY PERIODICALLY RENEWED AMMONIUM PERSULPHATE (10 PER CENT)

24-Hour Periods

Material	First 24 Hr.	Sec. 24 Hr.	Total 48 Hr.	Third 24 Hr.	Total 72 Hr.	Fourth 24 Hr.	Total 96 Hr.
Commercially pure iron	1.97	2.37	4.34	1.95	6.29	2.09	8.38
Coppered iron	2.15	2.47	4.62	2.06	6.68	2.25	8.95
Common steel	2.23	2.62	4.85	2.11	6.96	2.04	9.00
Coppered steel	2.72	3.24	5.96	2.58	8.54	3.11	11.65

48-Hour Periods

Material	First 48 Hr.	Second 48 Hr.	Total 96 Hr.
Commercially pure iron	2.42	2.22	4.64
Coppered iron	2.96	2.88	5.84
Common steel	2.81	2.66	5.47
Coppered steel	3.72	3.43	7.15

96-Hour Periods

Material	First 96 Hr.	Second 96 Hr.	Total 192 Hr.
Commercially pure iron	2.98	2.67	5.65
Coppered iron	2.99	3.34	6.33
Common steel	3.05	2.96	6.01
Coppered steel	3.50	3.51	7.01

50-Day Period

Material	End of 50 Days
Commercially pure iron	3.52
Coppered iron	3.82
Common steel	3.62
Coppered steel	3.96

Considering the 50-day test alone, it would appear that the coppered steel lost approximately 12 per cent more than the commercially pure iron samples, whereas the decisive short-time tests indicated that this percentage should be 39. Had 12-hour or 6-hour periods been used for the shortest time interval this percentage would no doubt be greater. In fact, as the interval between solution changes shorten, the weight losses obtained approach the true figures to be expected from actual service.

This series of experiments shows very clearly that valuable conclusions may be drawn from rapid tests conducted under proper conditions. Conclusions which have been derived from tests conducted in the past are open to question unless such tests were scientifically controlled, with due attention given to the variable molecular concentration of the various corroding media.

Recommended Procedure

The most successful means of conducting immersion tests, yet a procedure which will closely approach actual service conditions, is to immerse all test-pieces in one tank. The specimens should be suspended on glass rods

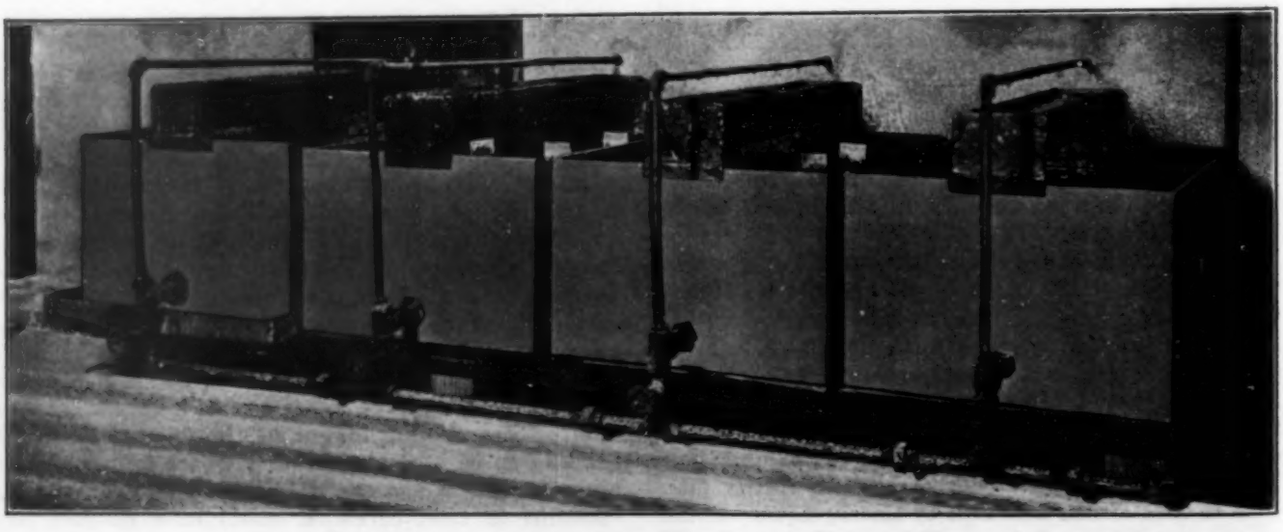


FIG. 1—ROW OF TANKS FOR CORROSION EXPERIMENTS

at distances apart sufficient to prevent any tendency toward electrolytic action. The tank should be ample in size to hold a large volume of the corroding liquid, so that when possible, the reacting chemical will be present in amounts in excess to the ferrous metals. Fig. 1 shows equipment adaptable for these suggestion.[4]

Although this illustration shows a metal tank, stoneware or enameled ware can be used equally as well. A convenient size is 12x18x30 in. An air lift is employed for circulating the solution. Air regulated by the globe valve and blowing up the vertical pipe from the bottom of the tank requires but a small amount of air to lift the solution from the bottom of the tank to a pipe parallel to and above the V-shaped trough which is placed between the pipe and the surface of the liquid. The solution will not only mix with air while passing through the pipes but will also have the opportunity to absorb additional air when dripping from the holes in the pipe into the trough and from the trough into the liquid in the main tank. Evaporation losses are equalized and temperature conditions are uniform when tests are conducted under the conditions described. Although the molecular concentration of the solution may vary continuously, yet at any moment of time the same strength of solution is attacking all grades of material under test. In investigations where the solution strength changes rapidly, it is possible to determine accurately this variable by daily tests and to fortify the liquid by calculated additions. If the reaction by-products form in appreciable amounts and exert either an accelerating or retarding influence, the entire solution can be easily changed.

Mercury Poisoning

There is probably no industry, trade or art in which mercury is used which has not produced some cases of mercury poisoning. In the mining and smelting of mercury the hazard has long been recognized.

The cases of industrial mercury poisoning occurring about mines and reduction works are usually chronic in form, with occasional development of acute symptoms when the workmen are exposed to undue amounts of mercury vapors, dust, or soot. The cardinal symptoms of the disease are stomatitis (inflammation of the mouth), often with some salivation, tremors and a peculiar timidity (erethism). These symptoms are accompanied by organic degenerative changes in various organs of the digestive system, circulatory system and the kidneys. Insufficient or improper ventilation of the working places, together with failure to maintain sufficient back pressure to prevent the escape of mercury vapor from furnaces, condensers and retorts, is a very important predisposing cause of the poisoning. Uncleanliness of the workmen appears to be no small factor in the production of the condition. Men who do not wash their hands well before eating or putting anything into the mouth, who do not care for their teeth and who fail to rinse the mouth well before eating and drinking, those who do not take a hot cleansing bath at the end of each day's work and who do not change their work clothing for street clothing after work develop poisoning more often than those taking these precautions.

Further details are given in Serial 2,354, just issued by the Bureau of Mines.

[4]This equipment was first described in "Observations on the Corrosion of Iron and Steel," by J. A. Aupperle and D. M. Strickland, American Electrochemical Society, 1921.

Plant Transportation, Plant Roadways and Concrete

By Graham L. Montgomery

OTHER things besides the selection of the correct machinery and appliances must be considered when purchasing the equipment for a plant transportation system. It is important to be able to form some opinion in advance as to just what effect the equipment will have on plant conditions other than material handling. It is important to determine the proper relations between the new equipment and the existing plant so that any changes that are necessary to enable the new equipment to function at its best may be made. It is often found necessary to make such changes, even when by so doing some interference occurs with other phases of the operation so as to reduce their efficiency. On the other hand, these changes often give benefits to some phase of operation other than transportation which had not been foreseen and which may actually be of as great or greater value than the benefit which the transportation derives. It will be seen, then, that any changes of this nature must be carefully weighed, and such disadvantages as may be foreseen balanced against the advantages that are to be derived, before a sound decision can be reached as to the course to be followed.

Plant Transportation

Chemical plants and many other plants of a similar nature often consist of a multiplicity of buildings, distributed over a wide area. Generally each building houses but one or two steps of the process at most, and often, as a result, the different steps are separated by considerable distances. This means that it is necessary to handle a large amount of material between the various buildings, from step to step of the processes. In addition the raw materials must be unloaded and then taken to the storehouse or to the primary step of a manufacturing process and the finished goods must be moved from the last step of manufacturing to the warehouse or shipping department.

This means that some form of mechanical transportation equipment is a necessity in such a plant. Of course, it is always wise for a manufacturer so to equip and organize his plant that costs of production are kept at a minimum. And this is particularly so under present conditions of manufacture, when the labor cost of manufactured goods is disproportionately high and the market conditions make it imperative to produce with the minimum of cost so that the goods may be held at a low enough price to find a ready sale.

Transportation Equipment

The equipment employed to accomplish this transportation will vary with the nature of the goods produced in the plant. In a plant where the goods are all of one class, the solution will rest in choosing the one type of equipment which is best suited to handling goods of this class. Many plants require several different types of equipment, as the handling includes several different classes of material. Thus we find handling equipment comprising traveling cranes, monorail hoists and some form of storage battery trucks in common use by large foundries for the solution of their transportation problems.

The largest category of these plants, however, is that in which the goods to be handled cover a wide variety of

sizes, shapes and weights and the physical constitution of the plant precludes any possibility of an economic utilization of such fixed-path equipment as a crane, monorail or industrial railway. Here the solution most commonly arrived at is to use a fleet of storage battery trucks, or a storage battery tractor or two with a fleet of trailers. The choice between truck and tractor and trailers rests on such factors as length of haul, speed at which it is desired to handle, character of handling and size of plant. In general, the choice falls on the truck when the haul is short, when the goods are light, when speed is desired, or the total to be moved is small, while under reverse circumstances the tractor and trailers get first call.

Plant Roadways

In all plants of the type here under discussion, when the transportation system utilizes trucks or tractors, there must be some sort of roads between the various buildings. It is obvious that the better these roadways are the more successfully the trucks and tractors can be used. The necessity for such roadways has long been a commonplace in a number of industries. In the metal-working industry we have many examples from the small unit made up of perhaps but two buildings with a paved runway between up to such huge units as the plants of the Ford Motor Co. or the General Electric Co., where the plant roadways become veritable speedways.

Unfortunately for the chemical and allied industries, they have not come to as keen a realization of the possibilities pointed out above as have plants in some other lines of industry. In the first place, despite the adverse conditions of labor market and sales market, by far the larger number of such plants have made no endeavor whatever to utilize mechanical handling devices of any kind. Then again, it is quite usual to find the roadways of these plants in a truly deplorable condition—rough, muddy, and, in wet weather, almost impassable.

The Concrete Solution

Apropos of these facts, it is worth while noting what has been done at the Rensselaer plant of the Grasselli Chemical Co. This plant is an ideal example of a plant consisting of numerous buildings and having a transportation problem to be satisfactorily solved only through the use of a tractor and trailers. The mud difficulty must have been particularly pronounced at this plant at one time, as it is on low lying ground, at best but little above normal water level of the Hudson.

In order to get away from this difficulty, concrete roadways have been built throughout the plant. The accompanying illustration shows one of these roads with the tractor and a train of trailers on it. It was stated to the writer that, by the placing of this concrete, which cost but little more than the tractor and trailers, full, continuous and satisfactory plant transportation had been attained. As closely as can be figured, the whole installation must have paid for itself in less than two years.

TRACTOR AND TRAILERS ON CONCRETE ROADWAY. GRASSELLI CHEMICAL CO., RENSSELAER, N. Y.

Now, as to the other influences which the placing of this concrete had on plant conditions: A clean and dry path was provided at all times from building to building. The appearance of the plant was greatly improved. These two things improve both the workers' health and their morale. The reflection of these improvements is apparent throughout the plant in increased efficiency and lowered production costs. It is, however, impossible to separate the exact amount of improvement out into dollars and cents, and so this amount must remain unnamed, although the management states that there is no doubt that it exists.

Conclusions

Although this matter of trucks and good plant roads is a simple one, its importance should not be overlooked. The profits to be realized—directly through the use of proper plant transportation equipment in a proper way and indirectly through generally improved conditions—are well worth attainment by any manufacturer. Just because a thing has not been customary in the past is no reason why it should not, provided it is worth while, become customary in the future. It will be well for the chemical and allied industries for this once to pattern on the metal-working industries, where the great successes of the past two decades have been made possible by the pioneering spirit which adopted new equipment and methods as fast as these could be proved sound.

Comparison of Methods of Cleaning Blast-Furnace Gas*

By N. H. Gellert

THE value of clean blast-furnace gas as against dirty or raw gas for use in blast-furnace stoves or in boilers has been so well demonstrated as to cause the largest and most progressive steel companies to spend millions of dollars to install cleaners.

If the gas issuing from a blast furnace were a small item, overlooking its importance might be permissible, but the facts are these:

1. Forty-eight to 50 per cent of the thermal value of the coke charged into the blast furnace issues from it in the form of latent and sensible heat of combustible gases.

2. Thirty per cent of the gas generated is used for increasing the temperature of the blast.

3. Sixty per cent of the gas is used in boilers or engines for power.

*Abstracted from *Mechanical Engineering*, May, 1922.

TABLE I—AVAILABLE HEAT IN CLEAN AND DIRTY GAS

Kind of Gas	Dust Content, Grains Per Cu.Ft.	Moisture Content, Grains Per Cu.Ft.	Temp. of Gas, Deg. F.	Available Heat, Per Cent
Raw gas	3.0	35.0	400	77.03
Partly clean gas	...	saturated	125	74.33
Clean gas	0.2	7.98	70	79.51

TABLE II—PROPERTIES OF GASES

Name of Gas (1)	Specific Gravity (2)	Lb. Per Cu.Ft. at 29.92 in Hg At 32 Deg. F. (3)	At 62 Deg. F. (4)	Heating Value B.t.u. Per Lb. (5)	B.t.u. Per Cu.Ft. At 32 Deg. F. (6)	At 62 Deg. F. (7)	Air Required Lb. Per Lb. Gas (8)	Cu.Ft. Per Cu.Ft. Gas (9)	Oxygen Required Lb. Per Lb. Gas (10)	Cu.Ft. Per Cu.Ft. Gas (11)	Cu.Ft. At 32 Deg. F. (12)	Gas Per Lb. At 62 Deg. F. (13)
Carbon dioxide	1.5291	0.1234	0.1163	.....	.....	.....	.....	.....	.....	...	8.103	8.60
Carbon monoxide	0.9672	0.0781	0.0736	4,325	337.6	318.2	2.47	2.391	.571	0.5	12.810	13.59
Hydrogen	0.0695	0.00561	0.00528	62,032	348.0	348.0	34.56	2.391	8.000	0.5	178.273	189.14
Oxygen	1.1054*	0.0892	0.0841	.....	.....	.....	.....	.....	.....	...	11.209	11.90
Nitrogen	0.9674*	0.0782†	0.0737	.....	.....	.....	.....	.....	.....	...	12.807	13.50
Air	1.0000	0.0807	0.0761	.....	.....	.....	.....	.....	.....	...	12.390	13.14
Aqueous vapor	0.6237	0.0503	0.0474	.....	.....	.....	.....	.....	.....	...	19.865	21.08
Methane	0.5545	0.0448	0.0422	23,513	1,053.4	992.2	17.28	9.564	4.000	2.0	22.324	23.70
Ethane	1.0496	0.0847	0.0799	22,230	1,882.9	1,776.1	16.13	16.737	3.733	3.5	11.807	12.51
Ethylene	0.9753	0.0787	0.0741	21,344	1,679.9	1,581.6	14.81	14.346	3.429	3.0	12.706	13.36
Acetylene	0.9056	0.0731	0.0688	18,196	1,330.1	1,251.9	13.29	11.955	3.077	2.5	13.680	14.63
Sulphur dioxide	2.2639	0.1826	0.1721	.....	.....	.....	.....	.....	.....	...	5.422	5.81
Sulphur	.....	.....	.....	4,050	.....	.....	4.32	.....	1.000	...	.....	.....
Carbon	.....	.....	.....	14,600	.....	.....	11.52	.....	2.667	...	.....	.....

* From Olsen's Manual. † Calculated. Columns 2 and 3, values from Liddell's Met. and Chem. Handbook; columns 4, 6, 7, 12, and 13, calculated; column 5, values from Poole's Calorific Power of Fuels; column 8, values from Babcock and Wilcox' Steam; columns 9, 10 and 11, from Pratt's Principles of Combustion.

Consider for a moment what clean gas will do for hot stoves. At Duquesne tests were made on hot-stove operations using gas in three different conditions. The results obtained, as given in Table I, are at least interesting.

Dry Versus Wet Cleaning

Now if it is conceded, by force of common practice and such data as can be used for argument, that clean gas is to be preferred above dirty gas in stoves and boilers, there remains but one other question to be answered: Shall gas be cleaned by a wet process or a dry process?

Heat Value of Dry-Cleaned Gas.—Suppose we consider the operation of a 500-ton furnace here in the Birmingham district. If every ton of iron required 2,500 lb. of coke, the total coke tonnage per day will be 625 tons. If we take 48 per cent of this to be in the form of gas, then 301 tons must be used for fuel purposes outside of the furnace. Here is presented a possibility for control that should result in savings.

Now there will be about 170,000 cu.ft. of gas generated per ton of iron made. At a 500-ton furnace this would give 85,000,000 cu.ft. of gas per day, 3,540,000 cu.ft. of gas per hour, or 59,000 cu.ft. per minute, at 29.92 in. of mercury column pressure and 62 deg. F.

Assume the gas has a percentage analysis as follows: CO_2, 12.5; CO, 25.4; H_2, 3.5; N_2, 58.6. Assume also that the temperature of the gas in the mains is 400 deg. F. and the moisture at standard conditions is 35 grains per cu.ft.

The thermal value of the gas depends on (1) its latent heat of combustion and (2) its sensible heat; and if the products of combustion escape at, say, 600 deg. F., there will have to be subtracted from the total heat the sensible heat of the escaping products of combustion.

Latent Heat.—First consider the thermal value of the gas.

Table II, the author believes, is the first published attempt to assemble the data given from a number of sources so as to collect the most probable values of the constants involved. In addition values have been calculated to correspond to a temperature of 62 deg. F., the temperature at which most technical gas calculations are made.

By the aid of this table it now becomes a fairly simple task to develop the latent-heat value of the gas which is being considered.

We have available 59,000 cu.ft. of gas per minute at 62 deg. and 29.92 in. mercury column. Of this amount, 14,986 cu.ft. is carbon monoxide and 2,065 cu.ft. hydrogen. The hydrogen has a total latent-heat value of 676,100 B.t.u. and the carbon monoxide a total latent-heat value of 4,771,100 B.t.u., or for all the combustible elements, a total latent-heat value of 5,447,200 B.t.u. per minute. See Table III.

Since, however, the water vapor formed in the combustion of the hydrogen is not condensed in the products of combustion, the lower heat value, 52,920 B.t.u. per lb., should hold. There must therefore be subtracted the difference between these two values for the total latent heat, or (62,032 — 52,920 =) 9,112 × 10.9 = 99,320.8 B.t.u. must be deducted, making the net value of the latent heat 5,347,900 B.t.u.

TABLE III—LATENT HEAT OF COMBUSTION
(59,000 cu.ft. of blast-furnace gas per min.)

Constituent	Per Cent By Volume	Cu.ft. Per Min.	Weight Per Cu.Ft. at 62 Deg. F., Lb.	Total Wt., Lb.	Per Cent By Weight	Latent Heat in B.t.u. Per Cu.Ft. at 62 Deg. F.	Per Lb.	Total
Carbon dioxide	12.5	7,375	0.1163	838.3	18.6	.....	.....	.....
Carbon monoxide	25.4	14,986	0.0736	1,103.2	24.6	318.2	4,325	4,771,100
Hydrogen	3.5	2,065	0.0053	10.9	0.2	328.0	62,032	676,100
Oxygen	0.0	0.000	0.0841	000	00	.....	.....	.....
Nitrogen	58.6	34,574	0.0737	2,548.3	56.6	.....	.....	.....
Total				4,500.7				5,447,200

Sensible Heat.—To this, however, must be added the value of the sensible heat of the gas. This may be determined from the formulas given in Table IV, which hold true for values of gases up to 2,000 deg. C. (3,600 deg. F.) in temperature.

TABLE IV—THERMAL CAPACITIES OF GASES PER POUND FOR TEMPERATURES UP TO 2,000 DEG. C. (3,600 DEG. F.)*

Gas	Pound-Calories	B.t.u.
Hydrogen	$3.370 + 0.0003t$	$3.370 + 0.00017t$
Nitrogen	$0.2405 + 0.0000214t$	$0.2405 + 0.0000119t$
Oxygen	$0.2104 + 0.0000187t$	$0.2104 + 0.0000104t$
Carbon dioxide	$0.19 + 0.00011t$	$0.19 + 0.00006t$
Carbon monoxide	$0.2405 + 0.0000214t$	$0.2405 + 0.0000119t$
Aqueous vapor	$0.42 + 0.000185t$	$0.42 + 0.000103t$

* Tabulated from data in Richards' Metallurgical Calculations.

We may approach our problem then in one of two ways:

1. We may find the mean specific heat of the gas between the limit $(0 — t_1)$, and also the mean specific

TABLE V—FORMULAS FOR SPECIFIC HEAT

Gas	B.t.u. Per Lb. Per Deg.
Hydrogen	$3.370 + 0.00017t$
Nitrogen and carbon monoxide	$0.2405 + 0.00000119t$
Oxygen	$0.2104 + 0.0000104t$
Aqueous vapor	$0.42 + 0.000103t$
Carbon dioxide	$0.19 + 0.00006t$

heat of the same gas between the limits $(0 - t_2)$. From the total sensible heat found in the first instance we may subtract the total sensible heat in the second leaving us a net result. Or,

2. We may find the mean specific heat between the limits $(t_1 - t_2)$ and use this direct to obtain our net sensible heat.

For ease in calculating specific heats the formulas in Table V may be used.

Take 500 lb. of carbon dioxide at 400 deg. F., to find its net sensible heat value if it enters a boiler when the air temperature is 70 deg. F. by the first method:

Specific heat of CO_2 (0°—400°) = 0.2140
Total sensible heat at 400 deg. F. = 0.2140 × 500 × 400
= 42,800 B.t.u.
Specific heat of CO_2 (0°—62°) = 0.1936
Total sensible heat at 62 deg. F. = 0.1936 × 500 × 62
= 6,002 B.t.u.
Net sensible heat (62°—400°) = 36,798 B.t.u.

Now calculating the specific heat of the gas at 400 deg. F., the following results are obtained:

	Mean Specific Heat in B.t.u. Per Deg. F. Per Lb.
Carbon dioxide	0.2140
Carbon monoxide	0.24526
Hydrogen	3.438
Nitrogen	0.24526
Aqueous vapor	0.4612

Let us see now how the values of the specific heats may be used in our calculations.

TABLE VI—DETERMINATION OF SENSIBLE HEAT OF BLAST-FURNACE GAS AT 400 DEG. F.

Given: 1. Total cu.ft. per min. at 62 deg. F. and 29.92 in. Hg dry basis = 59,000.
2. Moisture per cu.ft. dry basis (35 grains) = 0.005 lb.
3. Temperature of gas = 400 deg. F.
4. Percentage analysis, dry basis: CO_2, 12.50; CO, 25.40; H_2, 3.50; N, 58.60.

Constituent	Per Cent By Vol.	Cu.Ft. At 62 Deg. F.	Wt. Per Cu.Ft. At 62 Deg. F.	Wt., Lb.	Per Cent By Wt.	Specific Heat At 400 Deg. F.	B.t.u. Per Lb. At 400 Deg. F.	Total B.t.u.
CO_2	12.5	7,375	0.1163	838.3	18.6	0.2140	85.6	71,750
CO	25.4	14,986	0.0736	1,103.2	24.6	0.24526	98.1	108,220
H	3.5	2,065	0.0053	10.9	0.2	3.438	1,375.2	14,650
N	58.6	34,574	0.0737	2,548.3	56.6	0.24526	98.1	249,990
H_2O*	....	.....	0.005†	295.0	.....	0.4612	184.5	54,430
Total	100.0	59,000		4,795.7	100.0	0.2414§	96.57‖	499,040

* Aqueous vapor.
† Per cubic foot on basis of dry gas.
§ Average calculated value mean specific heat dry blast-furnace gas of above analysis.
‖ Per cubic foot dry gas.

In Table VI we consider the weights of the components of the gas and the sensible heat they possess by reason of their specific heat at 400 deg. F., the temperature at which they are passed through the hot-stove and boiler burners for combustion.

This determination of sensible heat is based on values of specific heats between the limits 0 deg. and 400 deg. F. To get an exact value they should be based on limits: temperature of air and 400 deg. F. Since this temperature varies from day to day and season to season, no data developed would hold exactly true. For purposes of comparison the method of determination used should give just as accurate, if not more accurate, results than a method in which daily temperatures must be estimated.

TABLE VII—SENSIBLE HEAT OF BLAST-FURNACE GAS AT 62 DEG. F.

Constituent	Weight, Lb.	Sp. Ht. At 62 Deg. F.	B.t.u. Per Lb. At 62 Deg. F.	Total B.t.u.
Carbon dioxide	838.3	0.1937	12.0	10,100
Carbon monoxide	1,103.2	0.2412	14.9	16,460
Hydrogen	10.9	3.3805	209.6	2,380
Nitrogen	2,548.3	0.2412	14.9	37,970
Aqueous vapor	295.0	0.4264	25.4	7,480
Total	4,795.7	0.2505		74,390

Assume, however, that this average temperature is 62 deg. F. We can then compute the total sensible heat at limits 0 deg.—62 deg. F. as in Table VII, and this subtracted from the sensible heat at the limits 0 deg.—400 deg. F. gives:

Sensible heat of gas at 400 deg. F.
= 499,040 — 74,390
= 424,650 B.t.u. per min.

The total heat of the gas at 400 deg F. will therefore be:

(1) Net latent heat of combustion..5,347,900
(2) Sensible heat of gas..... 424,650

Total thermal value.....5,772,550 B.t.u. per min.

Combustion Products

Now in a previous table the most probable values have been used as obtained from a number of sources, while the air and oxygen required were obtained from a source in which air was taken to consist of 23.15 per cent by weight of oxygen and 76.85 per cent of nitrogen. Since, however, our data show oxygen to weigh 0.0841 lb. per cu.ft. at 62 deg. F., while nitrogen weighs 0.0737 lb. per cu.ft. at the same temperature, the proportional parts in a cubic foot of air will be as given in Table VIII.

TABLE VIII—AIR-OXYGEN RATIO

Gas	Per Cent By Weight	Wt. Per Cu.Ft.	Proportionate Volume	Per Cent By Volume	Air-Oxygen By Weight	Ratio By Volume
Oxygen	23.15	0.0841	275	20.89	1.00	1.00
Nitrogen	76.85	0.0737	1,043	79.11	3.32	3.79
Air	100.00	0.0761	1,318	100.00	4.32	4.79

If, therefore, gas be burned by the combination with air, there will be present in the products of combustion, in addition to the new compounds formed, inert nitrogen amounting to 3.32 times the weight of the oxygen combined with the burning gases.

The combustion products when burning carbon monoxide and hydrogen will be as given in Table IX.

TABLE IX—COMBUSTION DATA

Constituent	Symbol	Air Required Lb. Per Lb.	Air Required Cu.Ft. Per Cu.Ft.	Products of Combustion—Lb. Per Lb. CO_2	Products of Combustion—Lb. Per Lb. H_2O	Products of Combustion—Lb. Per Lb. N_2	Products of Combustion—Cu.Ft. Per Cu.Ft. CO_2	Products of Combustion—Cu.Ft. Per Cu.Ft. H_2O	Products of Combustion—Cu.Ft. Per Cu.Ft. N_2
Carbon monoxide	CO	2.47	2.391	1.58	....	1.89	1	..	1.891
Hydrogen	H_2	34.56	2.391	....	9.00	26.56	..	1	1.891

By developing the calculations further (see Table X) we find that when the gas is burned the total products of combustion are:

Carbon dioxide..... 2,581.3 lb. or 22,361 cu.ft.
Water..... 393.1 lb. or 8,289 cu.ft.
Nitrogen..... 4,922.7 lb. or 66,818 cu.ft.
Total products of combustion... 7,897.1 lb. or 97,468 cu.ft.

Sensible Heat of Combustion Products.—These escaping products of combustion take with them out of the stack and into the air a portion of the heat by virtue of their thermal capacities. To know what heat is available for useful work, the sensible heat of these products must be determined at a temperature of 600 deg. F. Using the formula in Table VI, we are able to obtain the following values bearing on this determination:

	Mean Specific Heat in B.t.u. Per Deg. F. Per Lb.
Carbon dioxide	0.2260
Aqueous vapor	0.4818
Nitrogen	0.24764

At 600 deg. each pound of product will have 600 times

TABLE X—PRODUCTS OF COMBUSTION OF BLAST-FURNACE GAS

(59,000 cu.ft. per min. at 62 Deg. F.)

Constituent	Symbol	Per Cent By Vol.	Per Cent By Wt.	Weight, Lb.	Volume in Cu.Ft. At 62 Deg. F.	Total Air Needed Lb.	Total Air Needed Cu.Ft.	Products of Combustion—Total Lb. CO_2	Total Lb. H_2O	Total Lb. N_2	Total Cu.Ft. At 62 Deg. F. CO_2	Total Cu.Ft. At 62 Deg. F. H_2O	Total Cu.Ft. At 62 Deg. F. N_2
Carbon dioxide	CO_2	12.5	18.6	838.3	7,375	.....	.....	838.3	.....	.....	7,375	.....	.....
Carbon monoxide	CO	25.4	24.6	1,103.2	14,986	2,724.8	35,832	1,743.0	.....	2,084.9	14,986	.....	28,339
Hydrogen	H_2	3.5	0.2	10.9	2,065	376.7	4,937	.....	98.1	289.5	.....	2,065	3,905
Nitrogen	N_2	58.6	56.6	2,548.3	34,574	.....	.....	.....	.....	2,548.3	.....	.....	34,574
Aqueous vapor	H_2O	.....	.....	295.0	.....	.....	.....	.....	295.0	.....	.....	6,224	.....
Total		100.0	100.0	4,795.7	59,000	3,101.5	40,769	2,581.3	393.1	4,922.7	22,361	8,289	66,818

the thermal capacity here shown. The full analysis of the total thermal capacity of all the products can then be developed and this total sensible heat calculated to be 1,194,800 B.t.u., as shown in Table XI.

Here we must make the same corrections as made for the sensible heat of the gas. Our sensible-heat calculations for gases between the limits 0 deg. and 62 deg. F. are as given in Table XII and the net sensible heat of the products of combustion will be 1,194,800 — 114,380 = 1,080,420 B.t.u. per min. We then have:

TABLE XI—DETERMINATION OF SENSIBLE HEAT OF PRODUCTS OF COMBUSTION OF HOT GAS AT 600 DEG. F.

Constituent	Per Cent By Vol.*	Per Cent By Wt.*	Cu.Ft. At 62 Deg. F.	Total Weight, Lb.	Specific Heat At 600 Deg. F.	B.t.u. Per Lb. At 600 Deg. F.	Total B.t.u. Sensible Heat
Carbon dioxide	25.1	34.5	22,361	2,581.3	0.2260	135.60	350,020
Aqueous vapor	.....	.....	8,289	393.1	0.4818	289.08	113,640
Nitrogen	74.9	65.5	66,818	4,922.7	0.2476	148.56	731,320
Total	100.0	100.0	97,468	7,897.1	0.2522		1,194,980

* Figured on a dry basis.

TABLE XII—SENSIBLE HEAT OF PRODUCTS OF COMBUSTION

Constituent	Weight, Lb.	Specific Heat at 62 Deg. F.	B.t.u. Per Lb. At 62 deg. F.	Total B.t.u.
Carbon dioxide	2,581.3	0.1937	12.0	31,000
Nitrogen	4,922.7	0.2412	14.9	73,400
Aqueous vapor	393.1	0.4264	25.4	9,980
Total	7,897.1	0.2341		114,380

Total value of the original gas for both latent and sensible heat	5,772,550 B.t.u.
Net sensible heat of the products of combustion	1,080,420 B.t.u.
Gross available B.t.u.	4,692,130 B.t.u.
Less 10 per cent lost because of original loss in gas	469,213 B.t.u.
Net available B.t.u. per minute	4,222,917 B.t.u.

Available Heat and Flame Temperature in Dry Cleaning

All these figures are based on the assumption that blast-furnace gas is delivered at 400 deg. F. to the burners of the hot stoves and boilers. This is, of course, what a dry-cleaning device would enable the operator to do. If, however, he is forced to clean his gas by a wet process there must necessarily be a reduction in temperature of the ingoing gas. This reduction in temperature, it is true, will reduce the moisture content of gas. Whether this reduction in moisture content is of any considerable value, or whether it can compensate for the losses in heat incident to the cooling of the gas, is something that might well be determined. To arrive at a conclusion approaching a semblance of accuracy, two things must be taken into account:

1. The comparison of the flame temperature of the burning gases.
2. The comparison of net available B.t.u. of the gas.

We have already started our study of the available B.t.u. of hot gas containing 35 grains of moisture per cubic foot at 62 deg. F. and 29.92 in. Hg.

Let us consider for a moment the theoretical flame temperature of this gas.

$$T = \frac{\text{B.t.u. produced}}{W \times S_m}$$

where T = the elevation in temperature;
W = weight of products of combustion, and
S_m = mean specific heat of products between temperature of fuel and air and that of products.

The exact value of S_m cannot be found until the value of T is known. For that reason a trial method of computation must be adopted.

The average temperature of the fuel and air will depend on the temperature at which each was delivered to the point of combustion. The gas was delivered at 400 deg. F.; the air at 62 deg. F., and the temperature of the mixture can be shown to be about 251 deg. This figure is interesting but not necessary to our calculations, as we already have the total thermal value of the gas before burning.

Proceeding now to the determination of flame temperature, let us assume 2,480 deg. F. as the correct value. Then, dividing the B.t.u. produced by the sensible heat per degree at 2,480 deg. F., as given in Table XIII,

$$T = \frac{5,772,500}{2,470} = 2,340$$

It is evident that this is the wrong temperature. Assuming 2,400 deg. as the flame temperature,

$$T = \frac{5,772,500}{2,446} = 2,360$$

Again, taking 2,380 deg.,

$$T = \frac{5,772,500}{2,440} = 2,370$$

For our purposes we may take the halfway point between 2,380 and 2,370, or 2,375 deg. F., as the correct flame temperature. Greater accuracy may of course be obtained by another trial.

TABLE XIII—SENSIBLE HEAT OF PRODUCTS OF COMBUSTION PER DEGREE

Constituent	Total Wt., Lb.	Sp. Ht. At 2,480 Deg. F.	Sensible Heat Per Deg.	Sp. Ht. At 2,400 Deg. F.	Sensible Heat Per Deg.	Sp. Ht. At 2,380 Deg. F.	Sensible Heat Per Deg.
Carbon dioxide	2,581.3	0.3388	875	0.3340	864	0.3328	860
Nitrogen	4,922.7	0.2700	1,330	0.2691	1,320	0.2688	1,320
Aqueous vapor	393.1	0.6754	265	0.6672	262	0.6651	260
Total		0.2138	2,470		2,446		2,440

Available Heat and Flame Temperature in Wet Cleaning

So far there have been determined for the gas which is considered as cleaned by a dry process:

1. A value for the available heat which has been found to be 4,222,917 B.t.u. per min. This is the net value after all losses are accounted for.
2. A value for the flame temperature which is 2,375 deg. F.

We now approach the discussion of these same values when the gas is wet cleaned. In this instance the gas will have the same analysis as before, but its temperature will be 70 deg. F. and its moisture content 7.98 grains per cu.ft. of dry gas at 62 deg. and 29.92 in Hg.

Latent Heat.—Its latent heat will be exactly as before, since the heat values of the combustible constituents of the gas have not changed. This gross latent-heat value was found to be 5,447,290 B.t.u. per min.

From this amount there was subtracted the difference between the gross and net value of the heat generated by the combustion of the hydrogen, since there was no condensation of the moisture in the products of combustion before escaping through the stock. In addition there was deducted a 10 per cent loss in gas itself.

With the deduction for the lower thermal value of hydrogen there was a net latent-heat value left of 5,347,900 B.t.u. This holds true with wet-cleaned gas also.

Sensible Heat.—When we consider the matter of sensible heat, however, we have some differences to take into consideration.

The mean specific heats of the component parts of the gas at 70 deg. F. as calculated by the formulas in Table V are as follows:

Carbon dioxide	0.1942
Carbon monoxide and nitrogen	0.2413
Hydrogen	3.3819
Aqueous vapor	0.4272

With these values and such other data as we have already obtained, we may develop a table similar to Table VII, giving a total of 77,620 B.t.u. per min. for the sensible heat of all the gases. The total heat of the 59,000 cu.ft. of gas per min., therefore, is 5,347,900 + 77,620 = 5,425,520 B.t.u. per minute.

Combustion Products.—Turning to the consideration of the products of combustion of this gas, we find that all the products will be the same excepting the moisture content which will be less by the difference between 295 lb. as found in gas containing 35 grains of moisture per cu.ft. and 67.3 lb. is found in gas containing only 7.98 grains per cu.ft. This difference is 227.7 lb. The products of combustion will therefore be:

Carbon dioxide	2,581.3 lb. or 22,361 cu.ft.
Aqueous vapor	165.4 lb. or 3,480 cu.ft.
Nitrogen	4,922.7 lb. or 66,818 cu.ft.
Total	7,669.4 lb. or 92,659 cu.ft.

These products must be assumed to escape at the same temperature as before in order to get a reasonably accurate comparison. If the stack temperature is 600 deg. F. as before, the specific heats of the products will be the same as before. The total sensible heat of each product will also be the same as before, excepting that of the aqueous vapor. In the previous calculation 393.1 lb. of aqueous vapor had a total sensible heat value of 113,640 B.t.u., or 289.08 B.t.u. per lb. Then 165.4 lb. of aqueous vapor will have a sensible-heat value of 47,814 B.t.u. and the total sensible heat of the combustion products will be: (CO_2, 350,020) + (N_2, 731,320) + (H_2O, 47,220) = 1,128,560 B.t.u. per min. From this total there must be subtracted the heat energy present at 62 deg. F.

This will be the same as before, excepting for the aqueous vapor. In the former case 393.1 lb. aqueous vapor had a heat energy of 9,980 B.t.u. per min. Then 165.4 lb. of aqueous vapor which we have to deal with in this latter case will have a heat energy at 62 deg. F. of 4,190 B.t.u. per min. and the total energy will be: (CO_2, 31,000) + (N_2, 73,400) + (H_2O, 4,190) = 108,590 B.t.u. per min.

The net sensible heat of the products will therefore be 1,128,560 — 108,590 = 1,019,970 B.t.u. per min.

It is now possible to determine our net available heat.

Latent and sensible heat of gas	5,425,520
Less net sensible heat of combustion products	1,019,970
Gross available B.t.u.	4,405,550
Ten per cent gas loss	440,555
Net available B.t.u. per min.	3,964,995

Savings.—We have already found that the net available B.t.u. per min. when burning hot gas with 35 grains of moisture per cu.ft. = 4,222,917, and now we have the net available B.t.u. per min. when burning cold gas with 7.98 grains of moisture per cu.ft. = 3,964,995, giving a difference in favor of hot gas of 257,922 B.t.u. per min. or 371,407,680 B.t.u. per day saving in using hot gas over wet-cleaned gas.

On the basis of 500 tons per day the saving will amount to 371,401,680 ÷ 500 = 742,820 B.t.u. per ton. Now Birmingham coke contains about 14,290 B.t.u. per lb. on a dry basis. This would mean that 742,820 ÷ 14,290 = 52.0 lb. of coke is saved per ton of iron made. It is not unfair to take $6 per ton as the price of coke charged into the furnace. Then the saving in the use of hot gas will be (52 ÷ 2,000) × $6 = $0.156 per ton of iron made for coke alone.

Flame Temperature.—We have now to consider the flame temperature of this wet washed gas and with this consideration we are through with our discussion as to heat values. Let us assume the flame temperature to have a value between 2,000 and 2,400 deg. F. See Table XIV.

TABLE XIV—FLAME-TEMPERATURE CALCULATIONS

Constituent	Total Lb.	Sp. Ht. 2,000 Deg. F.	B.t.u. Per Deg.	Sp. Ht. 2,200 Deg. F	B.t.u. Per Deg.	Sp. Ht. 2,400 Deg. F	B.t.u. Per Deg.	Sp. Ht. 2,380 Deg. F	B.t.u. Per Deg.
Carbon dioxide	2,581.3	0.3100	800	0.3112	805	0.3340	860	0.3328	860
Nitrogen	4,922.7	0.2643	1,300	0.2667	1,315	0.2691	1,320	0.2688	1,320
Aqueous vapor	165.4	0.6260	100	0.6466	105	0.6672	110	0.6651	110
Total			2,200		2,225		2,290		2,290

Dividing 5,425,520 respectively by the values 2,200, 2,225 and 2,290 from that table gives 2,460, 2,450 and 2,370 deg. F., and we may therefore accept the flame temperature at 2,375 deg. F., the mean between 2,370 and 2,380 deg. F.

Curiously enough, the flame temperatures of the dry-cleaned and wet-cleaned gases as discussed thus far are the same. Practical experience bears this out also, as Diehl's observations indicate that during reasonable test periods the combustion chamber temperatures are 2,040 deg. F. on wet-cleaned gas and 2,030 deg. on hot raw gas. If the latter had been cleaned, our calculations show it would have had as high a temperature as wet-cleaned gas.

Our discussion on heat values of gas may therefore be summed up as follows:

1. Dry-cleaned gas at 400 deg. F., even if it contains 35 grains of moisture per cu.ft., has a greater available heat value than wet-cleaned gas at 70 deg. F. and 7.98 grains moisture per cu.ft. This heat is 6.5 per cent greater for the former gas than for the latter. At $6 per ton for coke charged into the furnace it means a saving of $0.156 per ton of iron made, in favor of using hot-cleaned gas.

2. There is no difference in flame temperature between the two gases.

Fuel Oil Viscosimeters

By Winslow H. Herschel
Petroleum Technologist, U. S. Bureau of Standards

IT WAS formerly common practice to base fuel-oil specifications upon gravity, but since investigations by the U. S. Bureau of Mines[1] proved that this was not a reliable index of the actual quality of the oil, present government specifications[2] are based upon the viscosity.

The viscosity of fuel oils is often so high that it cannot be measured with the Saybolt Universal viscosimeter or other instruments intended primarily for lubricating oils. The standard instrument for testing fuel oils in England is the Redwood Admiralty or No. 2 viscosimeter, or "viscometer," which is expensive and difficult to obtain in the United States. There appeared, therefore, to be need of an American-made instrument to serve a similar purpose, and the Saybolt Furol viscosimeter was developed by George M. Saybolt in the spring of 1920 at the suggestion and with the co-operation of the Bureau of Mines.

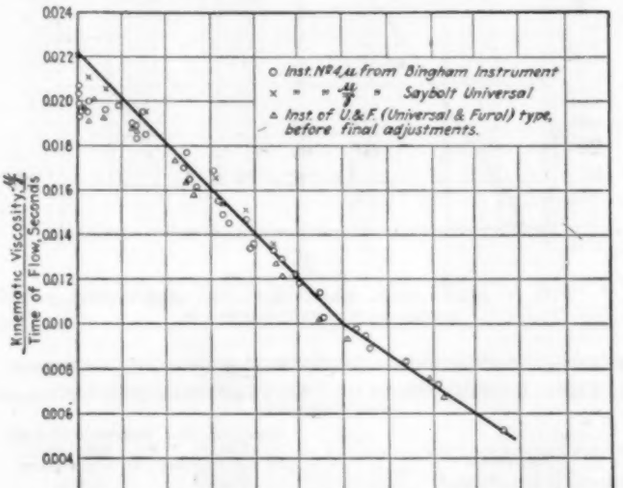

o Inst. No 4 at U. from Bingham Instrument
× " " " " Saybolt Universal
Δ Inst. of U. & F. (Universal & Furol) type, before final adjustments.
Kinematic Viscosity, ν / Time of Flow, Seconds
(Time of Flow, Seconds)²

FIG. 1—HIGGINS DIAGRAM FOR SAYBOLT FUROL VISCOSIMETER

The following paper will give an account of the standardization and calibration of this new type of viscosimeter as well as the calibration of the Redwood Admiralty type of instrument.

Saybolt Furol Viscosimeter

Saybolt Furol viscosimeter tube No. 4, submitted by George M. Saybolt, was measured at the Bureau of Standards, and on the basis of these measurements the standard dimensions of Table I were suggested to Mr. Saybolt by the bureau and accepted by him. The table also contains the dimensions of tube No. 4.

It will be seen that the standard dimensions are the same as for the Saybolt Universal viscosimeter[3] except d and d_3.

The shorter and larger the diameter of the outlet tube the greater must be the viscosity of the calibrating liquid, and while water could be used for the Ubbelohde viscosimeter, and ethyl alcohol solutions were made to suffice for the Engler and Saybolt Universal, it was necessary in the present case to use oils whose viscosity had been determined by the Bingham viscometer.[4]

TABLE I—DIMENSIONS OF SAYBOLT FUROL VISCOSIMETERS

Dimension*	Standard: Normal, in Centimeters	Standard: Tolerance, in Centimeters	No. 4, in Centimeters
Diameter of outlet tube, d	0.315	±0.002	0.3153
Length of outlet tube, l	1.225	±0.01	1.233
Outer diameter of outlet tube, at lower end, d_3	0.43	±0.03	0.41
Height of overflow rim above bottom of outlet tube, h_1	12.50	±0.1	12.571
Diameter of container, D	2.975	±0.02	2.981
Average head, h (calculated)	7.36	±0.2	7.46

* The normal dimensions are exact figures set up by convention. A dimension may be said to be standard when it comes within the permissible tolerance from the normal.

Figs. 1 and 2 show calibration diagrams obtained by the usual methods.[5] Points near the left side of the diagrams are inaccurate on account of the drainage error of the Bingham instrument, and were disregarded in drawing the calibration lines which represent the equation

$$\text{kinematic viscosity} = 0.0222t - \frac{2.02}{t} \qquad (1)$$

The bend in Fig. 1 shows that this equation does not apply when the time of flow is less than 13 seconds or when Reynolds' criterion is greater than 139. It should be noted that the value of Reynolds' criterion at the critical velocity decreases as $\frac{l}{d}$ decreases and that this ratio has a value of only 3.9 for this instrument. Fig. 1 also shows tests with an instrument of the U. & F. (Universal and Furol) type[6], before it had been adjusted to normal dimensions.

Equation 1 does not strictly apply to an instrument of normal dimensions, but such an equation may be obtained by using values of the Couette correction and the coefficient of the kinetic energy correction the same as found from Fig. 2. Thus with the former equal to

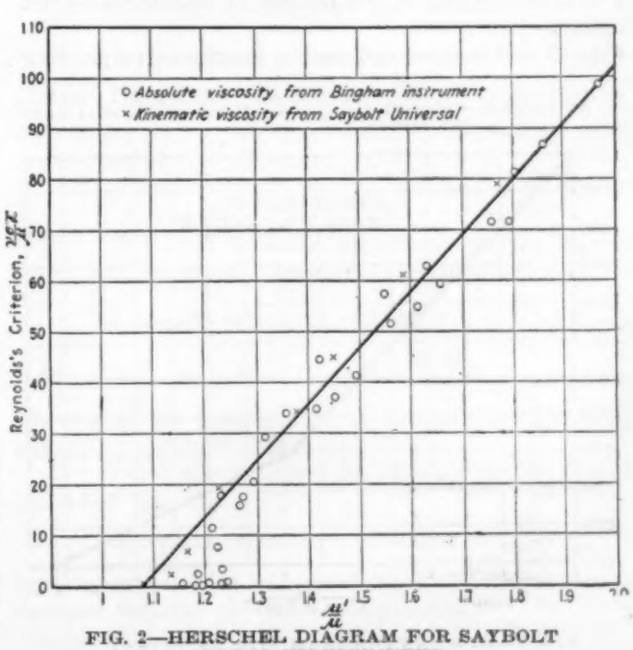

o Absolute viscosity from Bingham instrument
× Kinematic viscosity from Saybolt Universal
Reynolds's Criterion, 2lv / μ/ρ
μ/ρ

FIG. 2—HERSCHEL DIAGRAM FOR SAYBOLT FUROL VISCOSIMETER

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[1] E. W. Dean, Reports of Investigations, Serial 2215 (February, 1921).

[2] Tech. Paper 305, Bureau of Mines, "Specifications for Petroleum Products Adopted by the Interdepartmental Petroleum Specifications Committee, p. 9 (1922).

[3] Winslow H. Herschel, Bureau of Standards Technologic Paper 112, p. 7 (1919); A.S.T.M. Standards adopted in 1920, p. 105; *Proc.*, A.S.T.M., vol. 21, p. 642 (1921).

[4] E. C. Bingham and R. F. Jackson, Bureau of Standards Scientific Paper 298 (1917). E. C. Bingham, *Proc.*, A.S.T.M., vol. 18, part 2, p. 374 (1918).

[5] Winslow H. Herschel, Bureau of Standards Technologic Papers 100, 112, 125; *Proc.*, A.S.T.M., vol. 17, part 2, p. 551; (1917). *Proc.*, A.S.T.M., vol. 18, part 2, p. 364; (1918). *Proc.*, A.S.T.M., vol. 19, part 2, p. 676; (1919).

[6] As made by the American Instrument Co., Washington, D. C.

0.311d and the latter equal to 1.128, it may be calculated from the dimensions of Table I that for an instrument of normal or average standard dimensions,

$$\text{kinematic viscosity} = 0.0220t - \frac{2.03}{t} \qquad (2)$$

Redwood Admiralty Viscometer

The Admiralty instrument is described by Redwood as follows:[7]

> The author has devised a modified form of his viscometer, which, with the authority of the Admiralty, will be known as the Admiralty type, for testing oil fuel. This instrument, as its name indicates, has been specially constructed for use in determining the viscosity of oil fuel for contract purposes, and is intended to be employed at a temperature of 32 deg. F. (0 deg. C.). The oil vessel is of the same dimensions as that of the original instrument, but the agate jet is longer and of larger bore, the new viscometer being designed to give an outflow in one-tenth of the time occupied in the outflow of a similar volume from the original pattern. The jet is so mounted as to be surrounded completely by the water in the bath. The water bath, which is of comparatively large size and is jacketed, has no lateral heating tube, but is provided with the usual rotating stirrer. . . . The oil to be tested should be subjected to prolonged cooling at 32 deg. F. by being kept in a refrigerator through the night or for at least 6 hours immediately before being placed in the oil cup, and should be thoroughly stirred before being transferred. When accurate results are desired, the viscometer should be placed in a refrigerating chamber, the temperature of which is maintained at 32 deg. F.

It will be seen that this instrument is inconvenient to operate and entirely unsuited for tests at 122 deg. F. (50 deg. C.), the standard temperature for fuel oils adopted by the American Society for Testing Materials.

Higgins[8] gives equations for the two types of Redwood instrument which indicate that the time ratio is 9.63, while the value indicated by the equations determined at the bureau is 9.20. It would therefore appear that Redwood's value of 10 is only approximate.

Dimensions of two instruments are given in Table II, but no published data have been found to give the standard length and diameter of the outlet tube.

The Bureau of Mines instrument was used in the following tests except in the case of five oils tested by the Standard Oil Company of California on its Redwood Admiralty instrument. The kinematic viscosity of all oils was determined at the Bureau of Standards by the Bingham viscometer.

Figs. 3 and 4 show calibration graphs corresponding to Figs. 1 and 2 for the Furol instrument. They indicate the equation

$$\text{kinematic viscosity} = 0.0239t - \frac{0.403}{t} \qquad (3)$$

and the bend in Fig. 3 locates the critical velocity at which the time of flow is 5 seconds and Reynolds' criterion is 830. This increase in value of Reynolds' criterion, as compared with the Furol instrument, is due to the longer outlet tube of the Admiralty viscometer, which is 13.2 diameters in length.

According to Dean, Furol time equals 1.17 Admiralty time, but he does not show how this value varies with the viscosity. Higgins' equation for the Admiralty instrument, when reduced to c.g.s. units, gives

$$\text{kinematic viscosity} = 0.027t - \frac{12}{t} \qquad (4)$$

while the Kinney Manufacturing Co.[9] give this as

$$\text{kinematic viscosity} = 0.027t - \frac{20}{t} \qquad (5)$$

in accordance with a private communication received from the National Physical Laboratory. It does not seem probable that the difference between these results and equation 3 was due to a difference in dimensions of instruments, and equations 4 and 5 disagree also both with each other and with diagram of McCoull.[10]

[7] B. Redwood, "A Treatise on Petroleum," vol. 2, p. 277 (1913).
[8] W. F. Higgins, Collected Researches, National Physical Laboratory, vol. 13, p. 265 (1916).

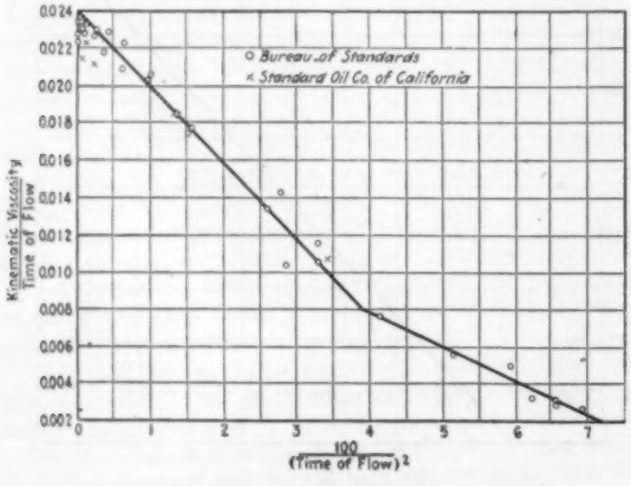

FIG. 3—HIGGINS DIAGRAM FOR REDWOOD ADMIRALTY VISCOMETER

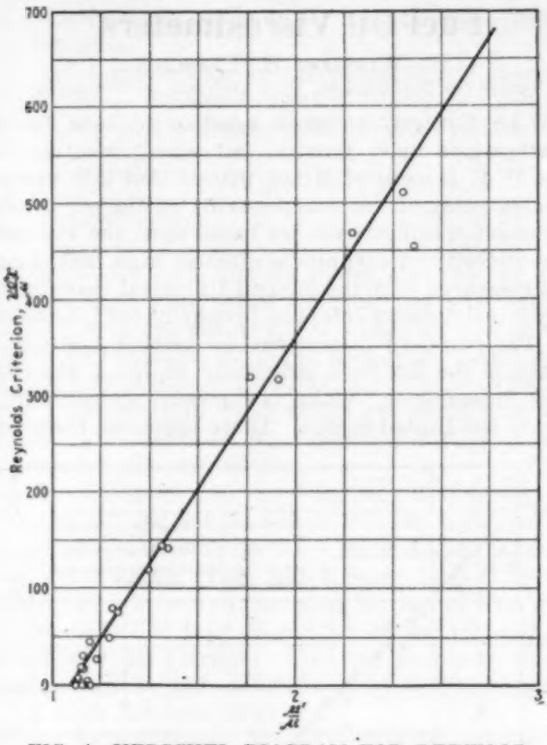

FIG. 4—HERSCHEL DIAGRAM FOR REDWOOD ADMIRALTY VISCOMETER

TABLE II—DIMENSIONS OF TWO REDWOOD ADMIRALTY VISCOMETERS

Dimension	Std. Oil Co., Cal.,* In Centimeters	Bureau of Mines,† No. 149, In Centimeters
Diameter of outlet tube, d	0.404	0.3896
Length of outlet tube, l	5.08	5.127
Height of gage point above bottom of outlet tube, h_1	13.36	13.457
Diameter of container, D	4.68	4.708
Average head, h (calculated)	.....	11.93

* Dimensions furnished by R. G. Smith.
† Measurements by Bureau of Standards of instrument loaned by E. W. Dean.

[9] "Friction Pressure Loss in Oil Pipe Lines" (1920).
[10] N. McCoull, "Lubrication," published by the Texas Co., vol. 7, p. 6 (May, 1921).

TABLE III—VISCOSIMETER CONVERSIONS

Multiplying Factors to Change Saybolt Universal Time to Furol or Redwood Admiralty Time

Saybolt Universal Time, Sec.	Kinematic Viscosity*	Time Ratio, Furol-Universal	Saybolt Universal Time, Sec.	Kinematic Viscosity*	Time Ratio, Admiralty-Universal
70	0.1283	0.1850	38	0.0362	0.1300
75	0.1410	0.1778	40	0.0430	0.1275
80	0.1535	0.1713	42	0.0495	0.1254
85	0.1658	0.1658	44	0.0559	0.1236
90	0.1780	0.1606	46	0.0621	0.1219
95	0.1901	0.1563	....	.....	.....
100	0.2020	0.1524	48	0.0681	0.1204
110	0.2256	0.1456	50	0.0740	0.1185
120	0.2490	0.1399	52	0.0798	0.1172
130	0.2722	0.1354	54	0.0855	0.1160
140	0.2951	0.1314	56	0.0911	0.1148
160	0.3408	0.1256	58	0.0966	0.1138
180	0.3860	0.1211	60	0.1020	0.1128
200	0.4310	0.1174	62	0.1074	0.1117
225	0.4870	0.1142	64	0.1127	0.1109
250	0.5428	0.1118	66	0.1179	0.1098
300	0.6540	0.1084	68	0.1231	0.1094
350	0.7649	0.1063	70	0.1283	0.1084
400	0.8755	0.1048	75	0.1410	0.1068
450	0.9860	0.1040	80	0.1535	0.1054
500	1.096	0.1032	85	0.1658	0.1042
550	1.207	0.1027	90	0.1780	0.1032
600	1.317	0.1023	95	0.1901	0.1020
650	1.427	0.1019	100	0.2020	0.1012
700	1.537	0.1015	125	0.2606	0.0983
800	1.758	0.1013	150	0.3180	0.0965
900	1.978	0.1011	175	0.3747	0.0954
1,000	2.198	0.1007	200	0.4310	0.0946
1,500	3.299	0.1002	250	0.5428	0.0938
2,000	4.399	0.1000	300	0.6540	0.0933
....	.....	.....	400	0.8755	0.0928
....	.....	.....	500	1.096	0.0925
....	.....	.....	750	1.648	0.0923
....	.....	.....	1,000	2.198	0.0922
....	.....	.....	1,500	3.299	0.0921

* From Winslow H. Herschel and E. W. Dean, Reports of Investigations, Bureau of Mines, Serial 2201, p. 11, January, 1921.

TABLE IV—VISCOSIMETER CONVERSIONS

Multiplying Factors to Change Saybolt Furol to Saybolt Universal or Redwood Admiralty Time

Saybolt Furol Time, Sec.	Kinematic Viscosity	Time Ratio, Universal-Furol	Time Ratio, Admiralty-Furol
13	0.1298	5.46	0.586
14	0.1631	6.00	0.628
15	0.1947	6.44	0.658
16	0.2252	6.85	0.685
17	0.2547	7.18	0.709
18	0.2833	7.49	0.730
19	0.3112	7.73	0.748
20	0.3386	7.94	0.763
22	0.3917	8.30	0.789
24	0.4433	8.58	0.810
26	0.4939	8.79	0.826
28	0.5435	8.95	0.839
30	0.5923	9.08	0.850
32	0.6405	9.19	0.858
34	0.6883	9.28	0.865
36	0.7356	9.37	0.872
38	0.7826	9.43	0.877
40	0.8292	9.49	0.881
45	0.9449	9.60	0.888
50	1.059	9.68	0.894
55	1.173	9.74	0.898
60	1.286	9.77	0.902
65	1.399	9.81	0.905
70	1.511	9.84	0.908
75	1.623	9.86	0.910
80	1.735	9.89	0.911
85	1.846	9.90	0.912
90	1.957	9.92	0.913
95	2.069	9.93	0.915
100	2.180	9.94	0.915
150	3.287	9.99	0.921
200	4.390	10.00	0.921

Further doubt is thrown upon equations 4 and 5 by the fact that they cannot be calculated from the dimensions of Table II with any reasonable values of the Couette correction and the coefficient of the kinetic energy correction, for which the values 1.05d and 1.123 respectively were obtained and used in calculating equation 3. The large value of 1.05d, as compared with 0.311d for the Furol instrument, may be due to increased surface tension, since the outlet tube of the Admiralty instrument is convex at the bottom and not closely restricted in outer diameter d, as is the Furol.

In a pamphlet entitled "Oil Flow in Pipe Lines," by R. S. Danforth of the Kinney Manufacturing Co., published in 1921, he made use of approximate equations which were the best available in May, 1921. These were:

TABLE V—VISCOSIMETER CONVERSIONS

Multiplying Factors to Change Redwood Admiralty Time to Saybolt Universal or Saybolt Furol Time

Redwood Admiralty Time, Sec.	Kinematic Viscosity	Time Ratio, Universal-Admiralty	Time Ratio, Furol-Admiralty
5	0.0389	7.77	.....
6	0.0762	8.50	.....
7	0.1097	8.99	.....
8	0.1408	9.35	1.660
9	0.1703	9.63	1.585
10	0.1987	9.86	1.516
11	0.2263	10.03	1.462
12	0.2532	10.16	1.417
13	0.2797	10.25	1.377
14	0.3058	10.33	1.342
15	0.3316	10.39	1.316
16	0.3572	10.45	1.293
17	0.3826	10.49	1.272
18	0.4078	10.53	1.255
19	0.4329	10.57	1.242
20	0.4578	10.59	1.227
22	0.5075	10.64	1.205
24	0.5568	10.67	1.188
26	0.6059	10.70	1.175
28	0.6548	10.72	1.162
30	0.7036	10.74	1.153
35	0.8250	10.76	1.136
40	0.9459	10.78	1.125
45	1.067	10.80	1.117
50	1.187	10.81	1.112
55	1.307	10.82	1.107
60	1.427	10.83	1.103
65	1.547	10.83	1.100
70	1.667	10.84	1.098
80	1.907	10.85	1.094
90	2.147	10.85	1.092
100	2.386	10.86	1.090
150	3.582	10.86	1.086

$$\text{For the Furol, kinematic viscosity} = 0.0218t - \frac{1.72}{t} \quad (6)$$

For the Admiralty,

$$\text{kinematic viscosity} = 0.023t - \frac{0.36}{t} \quad (7)$$

These agree fairly well with equations 2 and 3.

Conversion Tables

According to the rule adopted by the American Society for Testing Materials, the Saybolt Universal is to be used instead of the Furol instrument for time of flow less than 25 seconds on the latter and not less than 32 seconds on the former instrument. It is therefore important to be able to make conversions between these two instruments, as well as with the Redwood Admiralty. Tables III to V have been calculated for this purpose from equations 2, 3 and

$$\text{kinematic viscosity} = 0.00220t - \frac{1.80}{t} \quad (8)$$

equation 8 being for the Saybolt Universal viscosimeter. The multiplying factors given in the last line hold good for all higher viscosities. Conversion factors for use with lower viscosities than given in the tables should not be obtained by extrapolation.

Conclusions

(1) The most probable equations for the Saybolt Furol and Redwood Admiralty viscosimeters are

$$\text{kinematic viscosity} = 0.0220t - \frac{2.03}{t} \quad \text{(Furol)}$$

$$\text{kinematic viscosity} = 0.0239t - \frac{0.403}{t} \quad \text{(Admiralty)}$$

where t is the time of flow in seconds and kinematic viscosity is expressed in c.g.s. units.

(2) These equations and the equation for the Saybolt Universal viscosimeter

$$\text{kinematic viscosity} = 0.00220t - \frac{1.80}{t}$$

have been used to calculate tables for making conversions between the three instruments.

Petroleum Laboratory,
U. S. Bureau of Standards,
Washington, D. C.

Söderberg Self-Baking Continuous Electrodes

Outline of Process of Manufacture of Continuous Electrodes at Furnace—Installations in Various Types of Furnaces: Ferro-Alloy; Carbide; Steel; Electric Pig Iron—Advantages Over Ordinary Carbon Electrodes—Cost Comparisons—Probable Trend of Future Developments

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THE Söderberg self-baking electrode is a continuous electrode, which is built, baked and renewed right in the furnace where it is being used. It is an everlasting electrode, which once installed in a furnace will continue to work without change year after year through the whole lifetime of the furnace.

Manufacture of the Electrode

The principal way of making the electrode is shown in Fig. 1. The electrode consists of a casing of small-gage sheet metal (usually iron) into which ordinary electrode mixture is tamped. The casing serves to give the electrode the right shape while tamping, to reinforce the unbaked part and to help carry the current from the electrode holder to the baked part of the electrode. It further serves to protect the electrode against air corrosion. In order to give the casing a sufficiently good mechanical and electrical contact with the electrode carbon it is given a rather peculiar shape, which is shown in Fig. 2. As will be seen, the casing is provided with ribs extending radially into the electrode. The electrode is suspended in the furnace by means of an electrode holder, which is constructed as a clasp holder that can easily be moved along the electrode. The electrode is very long, and its upper part is surrounded by a tamping platform or a closed tamping house, where the lengthening of the casing and the tamping in of new electrode mixture may be carried out as often as necessary, without the workmen being exposed to the heat from the furnace. The tamping is usually done by pneumatic rammers.

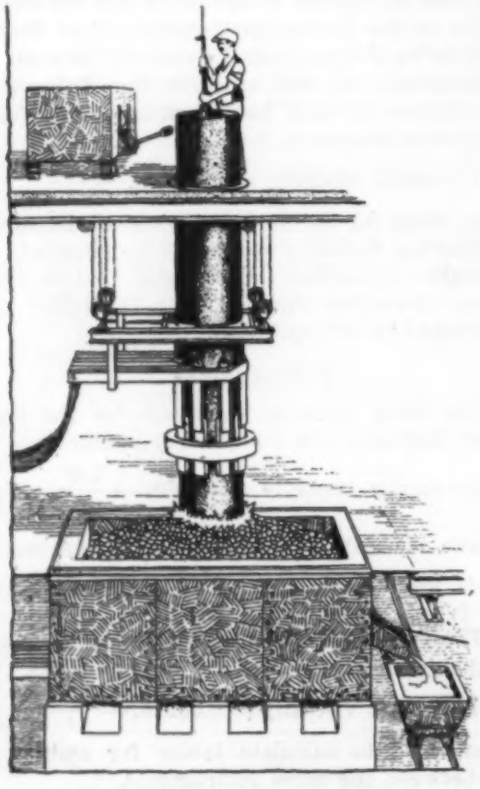


FIG. 1—METHOD OF MAKING SODERBERG ELECTRODES

The lower end of the electrode is placed in the smelting furnace, where it is baked by means of the heat from the furnace crater and by heat developed in the electrode itself through the electric current. The electrode will therefore consist of a lower (or internal) fully baked part, and an upper (or external) raw and unbaked part. The electrode holder is ordinarily placed on the lower baked part of the electrode, but may be placed anywhere if the cross-section of the iron casing is sufficient to conduct the current from the holder to the baked part of the electrode. When the holder is placed on the baked part of the electrode, the iron casing commonly used will average about 5 per cent of the weight of the baked carbon, the thickness of the iron in the casing being B.G. gage 22 to 16. Moving the electrode in the holder is done by simply loosening 3 or 4 screws on the holder until the electrode will gradually sink by its own weight. When the electrode has sunk sufficiently (usually 10 to 30 cm.), the screws are tightened. This operation is carried out at full current load, with no interruption in the working of the electrode, the current load being always maintained by means of the sliding contact between the electrode holder and the electrode.

FIG. 2—CONSTRUCTION OF CASINGS

Joints Eliminated

When the electrode begins to get too short, a new section of iron casing is welded to its upper end and warm electrode mixture is tamped in. The old mixture

is still soft and will mix completely with the new mixture, making the electrode absolutely uniform and with no joints. Taking into consideration the fact that the joint is always a weak part of the ordinary threaded electrodes, it will be obvious that the Söderberg electrode has a great advantage over ordinary electrodes in this respect.

As in all open furnaces, the electrode holder is well water-cooled, and is suspended in a frame that may be moved up and down by means of a winch and regulated either automatically or by hand.

First Installation

The first furnace to use a Söderberg electrode was a ferrosilicon furnace which was put in operation by the A/S. Fiskaa Verk per Kristianssand S., Norway, in November, 1918. This first electrode was 600 mm. in diameter. In July, 1919, it was replaced by a 850-mm. electrode, and this electrode has been working continuously ever since without a single shutdown due to the electrode and without any electrode breakage—results which have hitherto been unobtainable. Electrode consumption is considerably reduced, and air corrosion is eliminated to a very great extent, due to the good protection afforded by the iron casing and the electrode holder. The baked electrode is equal in quality to the best ordinary electrodes. The cost of manufacture is relatively very low.

In May, 1921, a second electrode (rectangular, 1,150 x 500 mm.) was placed in the furnace. The furnace load was raised to about 2,000 kva. This rectangular electrode has also worked very well, with about the same efficiency and electrode consumption as the round electrode. Both electrodes are shown in Fig. 3. The furnace operates on three-phase current, Scott-connected.

Space does not permit consideration at the present

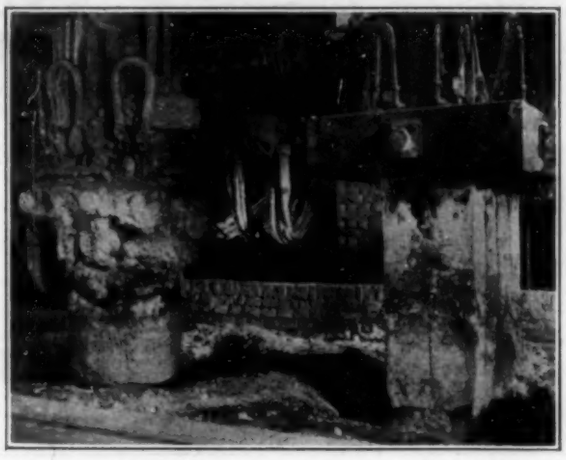


FIG. 3—FIRST INSTALLATIONS AT FISKAA VERK

time of many important and interesting details in connection with the manufacture and operation of the Söderberg electrode.[1]

Properties of the Electrodes

As mentioned above, the lower part of the electrode is perfectly baked when in use. The electrode works exactly as an ordinary carbon electrode, and needs no special attention of any kind. It looks like and has the properties of ordinary electrodes and differs in no way from them either with regard to specific gravity, electrical conductivity or mechanical strength. Common Söderberg electrodes show thus:

Specific gravity, about	1.5
Electric resistance, ohms per cu.cm.	0.007
Crushing strength:	
Kg. per sq.cm.	150
Lb. per sq.in.	2,200

The electric resistance given above is that of the cooled, baked electrode carbon. Due to the good conductivity of the iron casing, the total conductivity of the bake part of the electrode is still better than

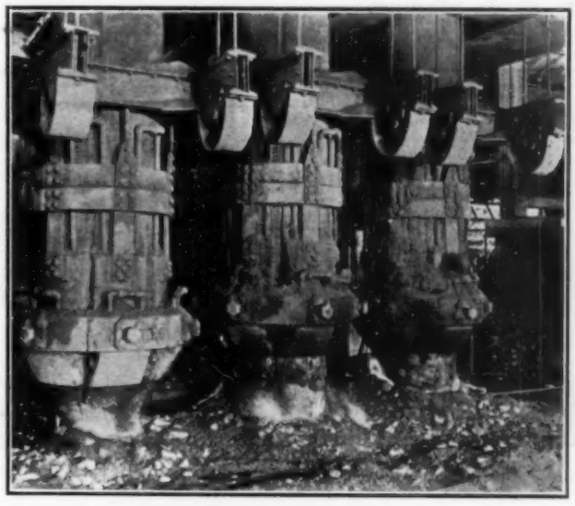


FIG. 4—ELECTRODES AT SOUTHERN MANGANESE CORP. PLANT

this figure indicates. The electric resistance of the hot electrodes (1,000 to 2,000 deg. C.) is about 0.003 ohm per cu.cm. It is therefore possible to operate the self-baking electrodes at a higher current density than ordinary electrodes, and it is further possible to regulate the electrical conductivity to a great extent by the weight of the iron casing in relation to the weight of the baked electrode carbon. In November, 1920, a 400-mm. rectangular electrode was operated continuously at a current density of 10 amp. per sq.cm. At intervals the current load was increased for a short period up to 18 amp. per sq.cm.

Due to the good electrical conductivity of the electrode and the short distance from the holder to the lower end of same, the voltage drop in the electrode is relatively low. At Fiskaa it is ordinarily between 1.3 and 1.9 volts. The heat loss in the cooling water is between 5 and 7 per cent of energy consumed in the furnace.

Other Installations

Söderberg electrodes have since been installed in furnaces all over the world. The first installation outside of Fiskaa was in a 300-kw. furnace for smelting nickel matte at Kristianssands Nikkelraffineringsverk, Kristianssand S., Norway.

Then followed an installation in a 1,800-kw. three-phase ferromanganese furnace at the Southern Manganese Corporation, Anniston, Ala. This furnace (Fig. 4), which was put in operation in July, 1920, for the manufacture of ferromanganese from Caucasian ore, was described by Prof. J. W. Richards in *Trans.*, Am. Electrochem. Soc., 1920, p. 351.[2]

[1] A detailed description may be found in *Teknisk Ukeblad*, Christiania, 1920, No. 25. See further J. W. Richards, *Trans.*, Am. Electrochem. Soc., 1920, p. 169.

[2] See also F. W. Andreae, *Schweizerische Bauzeitung*, 1921, p. 120.

About Sept. 6, 1920, an installation at A/S. Arendal Smelteverk, Eydehavn, Norway, was put in operation. The installation consists of two electrodes each 950 mm. in diameter in a two-phase 4,000-kw. furnace with two furnace craters. The furnace is running on ferrosilicon (50 and 75 per cent Si). In this furnace also the electrodes proved to be very much superior to ordinary electrodes in regard to both electrode consumption and furnace output. The consumption of Söderberg electrodes is about one-half that of ordinary electrodes, working on the same alloy in the same furnace. The direct savings obtained are so important that the total cost of the installation will be saved by less than one year's continuous running.

While the electrodes in the Arendal plant are 40 per

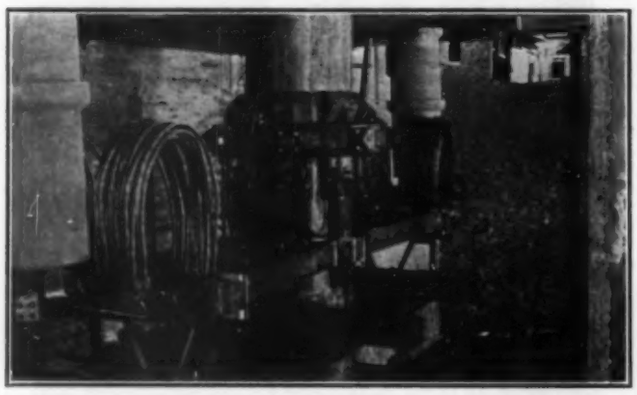


FIG. 5—GULLSPANG CARBIDE FURNACE

cent greater in cross-section than the largest ordinary single electrodes, there is no doubt that electrodes of still larger size can be made.

Application to Calcium Carbide Furnaces

Calcium carbide furnaces are also using Söderberg electrodes with excellent results. Fig. 5 shows the installation of a 850-mm. (34-in.) electrode in a 1,400-kw. carbide furnace at Gullspang, Sweden. The latest installation is in a 6,000-kw., three-phase carbide furnace in the Knapsack plant of the A/G. für Stickstoffdünger at Cologne, Germany. This furnace (Fig. 6) is provided with three 950-mm. (39-in.) electrodes, and was put in operation in August, 1921.

The electrodes are about 7 meters long, and the upper ends are surrounded by a tamping house with its floor 4.5 meters above the platform of the furnace. The house is built of reinforced concrete, and is completely closed except for a long passage leading to the outer air. Fresh air is provided through a ventilator. In order to be able to regulate the temperature in the tamping house, the concrete floor is reinforced by iron tubes for water-cooling. The temperature in the tamping house is always lower than in the smelting house.

The average results of three months' running show a reduction in the electrode consumption of about one-third. At the same time the output of the furnace per kilowatt-hour was raised considerably. At present the whole plant, consisting of nine furnaces each, rated at about 6,000 kw., is to be provided with Söderberg electrodes, and some of the furnaces are already being rebuilt.

It may be of interest to note that some carbide producers have referred to the fact that part of the iron from the iron casing of the electrode will pass into the carbide and reduce the quality of the product. This may at first glance seem to be a strong objection. However, a calculation shows that only 0.1 to 0.2 per cent of iron can be transferred to the carbide from this source, while ordinary carbide always contains about ten times as much iron. The amount in question is thus of no importance whatever.

Besides the installations described, Söderberg electrodes are at present installed or in course of installation in ferro-alloy and carbide furnaces in Sweden, Italy, France, Germany and South Africa.

Use in Electric Steel Furnaces

Also in closed furnaces the new electrodes have been tested and brought in permanent industrial use. In September, 1920, a 500-mm. (20-in.) Söderberg electrode was installed in a 7-ton Heroult steel furnace of the Stavanger Electro-Staalverk A-S., Jörpeland per Stavanger, Norway (Fig. 7). The electrode was first installed provisionally (the ordinary electrode holder of the furnace being used) and run together with ordinary electrodes. From the very beginning the results were so good that a permanent installation was made. In order to get comparative results the electrode was then run together with German electrodes of best steel furnace quality and other ordinary electrodes. The year

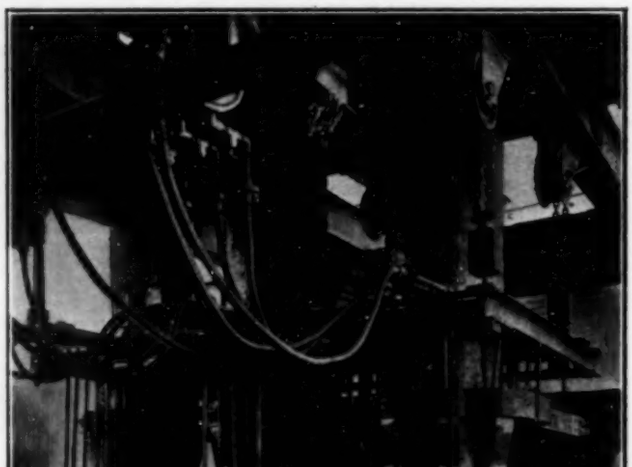


FIG. 6—6,000-KW. CARBIDE FURNACE AT KNAPSACK

1921 shows an electrode consumption for the Söderberg electrodes which is only 58 per cent of that for the German electrodes used in the same furnace, although the Söderberg electrodes were made of very poor raw materials, so that the ash content was about 15 per cent. As will be seen from Fig. 7, lengthening of the electrodes on the top of the furnace has not been provided for. The electrodes are lengthened outside the furnace, which may easily be done when using small Söderberg electrodes. When using big electrodes the changing will, however, be rather difficult, and it may

be more practical to provide a tamping platform which will tilt with the furnace and which may be removed from the furnace by means of a crane when the roof of the furnace has to be renewed. It may also be possible to arrange the platform fixed to the wall in the furnace house, in which case the platform will have to be constructed in such a way as to permit the electrodes to be tilted with the furnace. It will depend upon local conditions which arrangement will be most satisfactory from the standpoints of electrode renewal and furnace operation.

Further installations in steel furnaces are at present being made in Germany, and others are under consideration in England, France and Italy.

Another step to utilize the Söderberg electrodes in closed furnaces is the installation of 2,700-mm. (29-in.)

FIG. 7—APPLICATION TO TILTING STEEL FURNACE

electrodes in an electric pig-iron furnace of the Elektrometall type in Domnarfvet, Sweden. These electrodes were run from September to November, 1921, at which time the furnace had to be shut down owing to lack of water power. During the whole time the electrodes worked without a single breakage and with an energy load about 40 per cent higher than the load used for the ordinary electrodes in the same furnace. The potential required for the proper working of the Söderberg electrodes was about 5 volts (per set of two electrodes) lower than with ordinary electrodes, evidently due to the better contact between electrode holder and carbon and to the good conductivity of the electrodes. At present six Söderberg electrodes are being installed in this furnace.

It is therefore obvious that the utilization of the Söderberg electrodes also in the existing closed furnaces shows very great advantages. It should prove of still greater importance in the future development of closed furnaces. It is now possible to increase the size of the furnaces without increasing the number of the electrodes. This fact is thought to be of special importance in developing types of closed furnaces for the manufacture of calcium carbide and ferro-alloys.

Summary of Advantages

Operating data on Söderberg electrodes indicate the following advantages:

1. The cost of the electrodes is reduced very much.
2. The cost of special mounting and protecting the electrodes against air corrosion is avoided.
3. The baking is done without cost, as it is done by waste heat from the furnace crater. (The heat loss through the electrode is in fact less than for ordinary carbon electrodes.)
4. The electrode consumption is reduced:
   (*a*) Because the Söderberg electrodes have no electrode butts.
   (*b*) Because the air corrosion is very small.
   (*c*) Because fractures do not occur.
5. The running of the furnace is more regular because there are no stops due to change of electrodes and other troubles experienced with ordinary electrodes.
6. Every individual plant will be independent of electrode factories and will be able to make its own electrodes of the quality and shape most suitable.
7. The number of laborers can generally be reduced and the working conditions are improved, as the laborers are not so much exposed to heat.
8. It is possible to make new furnace constructions, which opens up possibilities for further development of the smelting industry.

Comparative Costs

The electrodes can be installed in most electric melting and smelting furnaces and can be built in all shapes and sizes, both round and rectangular. The cost of installation is relatively low—for two electrodes in a 2,000-kw. ferrosilicon furnace it would be about $6,000 and the time required would be from 1 to 2 months.

The cost of electrodes mounted in the furnace and ready for use is estimated at about 2 to 3c. per lb., including amortization and interest. This estimate will of course depend upon the prevailing prices of anthracite, coke, tar, pitch and labor.

The price given above is calculated for electrodes of about 34-in. diameter. Smaller electrodes will be somewhat more and larger electrodes somewhat less expensive. The electrodes may be produced still more cheaply if no anthracite is used in the electrode paste, in which case the electrodes will have to be made of foundry coke together with retort carbon or similar material. Such electrodes have been used with very good results in Fiskaa Verk for several months.

It may be of interest to show by an example what savings may be expected from the use of Söderberg electrodes instead of ordinary carbon electrodes. In most open furnaces now with 25 per cent of electrode butts, the electrode consumption will be reduced at least 35 per cent, in which case 10 per cent of the reduction is due to less air corrosion of the Söderberg electrodes. If ordinary electrodes cost 4c. per lb., the savings will be as follows:

Price of ordinary electrodes per 2,000 lb.	$80.00
Cost of mounting and protection against air	10.00
	$90.00
500 lb. of electrode butts obtained worth $10 per 2,000 lb.	2.50
Cost of 1,300 lb. electrodes consumed in furnace	$87.50
Cost per 2,000 lb. consumed electrodes	$135.00
Cost of 2,000 lb. Söderberg electrodes	40.00
Direct savings	$95.00

To these direct savings should be added the indirect

savings due to elimination of electrode changing; less repair on contacts, cables, etc.; more regular running; easier operation of the furnaces; higher output, etc.

Probable Trend of Developments

It was mentioned above that the Söderberg electrode makes possible new furnace constructions which may lead to new developments for the electric melting and smelting industry. In trying to picture the possibilities of development which the new electrode embodies for the electric furnaces, it is first necessary to review the drawbacks of the ordinary electrodes. The most prominent drawback is that they are limited in regard to length and section. It is impossible to make electrodes larger than about 7 ft., in length and 32 in. in diameter. It is, of course, possible to join electrodes over the furnace by the aid of thread and nipple, and in this way certain types of furnaces have continuously working electrodes, but this method cannot be successfully applied to other than round electrodes, and consequently not to electrode packets, and secondly the electrode joints even if ever so carefully made are liable to be the cause of trouble and fractures. To join electrodes over open furnaces is a difficult job.

Larger Furnaces Possible

Söderberg electrodes are not limited in regard to length or to section. Accumulated data all seem to indicate that electrodes are more steady and satisfactory in operation the larger they are. If there are no limits to the size of the electrodes, there will be no limits to the size of the furnaces either, and this being the case the self-baking electrodes have broken down the barrier which up to this time has impeded the evolution of large sized furnaces. When alternating currents are used for smelting, there is certainly a limitation to the size of the electrodes, or rather to the number of amperes, owing to the phase-displacement and the skin-effect, which will be quite noticeable at very high current load. Thorough investigations show, however, that when using a 50-cycle current, it is possible to make round electrodes of 1.75-meter (71-in.) diameter, if the current density in the central part is permitted to become 50 per cent less than at the surface. A 39-in. electrode would show a divergence of 10 per cent. By using twenty-five or fifteen-cycle current and allowing a divergence in the current density of 50 per cent, it is possible to make electrodes of 2½ meters (100 in.), or 3.20 meters (130 in.) respectively. An electrode of 3.20-meter diameter will at a current density of 3 amp. per sq.cm. (20 amp. per sq.in.) conduct a current of 240,000 amp., which at a voltage of 60 would develop—by means of this single electrode—14,400 kva.

Special Shapes Possible

With this last figure the ultimate limit is not by any means reached. It will be possible to reduce the number of cycles still more, or even work with direct current. Besides, the electrodes may be given such shapes that the skin-effect will be less—for example, by making the electrodes rectangular with one side much longer than the other, or by giving the electrodes the shape of hollow cylinders. It is thus clear that the electrodes can be made considerably larger than they are made today. With the increase in the size of the electrodes follows the possibility of giving the electrodes special shapes to meet the requirements of each special process. This possibility can be utilized in different ways. Being shaped directly over the furnaces in which they are used, the electrodes may thus be provided with channels running throughout their whole length. For larger electrodes such a channel may be made so wide that it will fulfill the object of the furnace shaft, serving, for example, for drawing off the furnace gases or for charging the furnace, putting on either the whole charge through the channel or only a certain part of the same. At present these forms of the electrodes are only future possibilities, but it has already been experimentally proved that hollow electrodes can be run without difficulties.

To meet present requirements it is necessary to concentrate the work on the application of the electrodes to furnaces and furnace types in operation. There is, however, no doubt that what are today the more remote possibilities of the new electrode will soon be drawn into practical use. The Söderberg electrode will become of fundamental importance to the electric smelting practice and may open up a new field of modern electrothermic industry.

Synopsis of Recent Chemical & Metallurgical Literature

Machines for Men.—In the *Gas Age-Record* for May 27, 1922, Floyd W. Parsons states editorially that great economies can be made to result from the substitution of machines for men, especially in material-handling operations. Machines do not strike, and when given proper attention they seldom or never lie down on the job.

One remedy for excessive labor costs is more machines. Here in the United States we boast of our mechanical aptness, but the truth is that in many of our industries we have been backward in adopting material-handling equipment. Not more than one-half of our manufacturers are familiar with modern mechanical methods for handling materials. If mechanical means for loading and unloading railroad cars were to be provided, so that one hour might be saved each day for each car, it is a fact that the total savings would amount to something like 2,600,000 car-hours per day, which would be equivalent to adding more than 100,000 cars to our present supply of rolling stock. The annual wage cost of handling freight in this country is more than $900,000,000. We could save 40 per cent of this sum through the installation of material-handling equipment. On the antiquated piers in New York it costs more per ton to handle food and merchandise than it costs to transport it 1,000 miles by rail.

The important thing here is not the operating cost of ships, cars and other utilities, but the cost of keeping them idle. It would be a splendid thing if every manufacturer were immediately to start making a thorough investigation of every operation inside and outside his plant, with the idea of discovering where and how men might be dispensed with and machines substituted for the work in hand. Handling practices are crude in many plants, and large economies would result from modernizing methods and equipment.

German Experience With White Alloys.—*Engineering* reports a recent discussion of die-casting alloys, in which was voiced much complaint as to the durability of many "war substitutes" and more recently exploited compositions. Sand-cast articles of the same alloys have also given considerable trouble. The long-known castings of tin-lead alloys are not strong, have low melting points and must not be heated above 100 deg. C. subsequently, but they shrink little and keep their exact dimensions. Pure zinc is not suitable for die casting; alloyed with tin, or with copper or aluminum, it answers; but tin and aluminum do not go together in general. Tinfoil containing more than 0.2 per

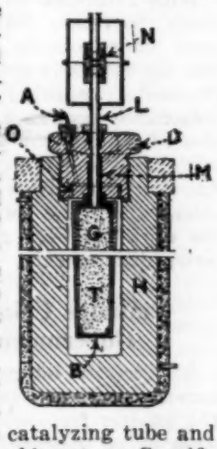
cent of aluminum may crumble in a few days. In complex alloys of zinc and aluminum the influence of tin is less clear. Zinc-tin alloys (for the mouthpieces and horns of telephone apparatus) should not be varnished at temperatures above 150 deg. C., lest a tin alloy sweat out in beads. The Siemens Co. exhibited a great many specimens of alloys, essentially of zinc-aluminum, both sand and chilled castings, which had failed, cracked, expanded or shrunk and had become distorted. The Al percentages varied between 2 and 70 in these products, which contained also copper, lead, and sometimes tin. It was mentioned that in America the use of alloys of Al-Zn, with medium Al-percentages, had been abandoned by some firms. Some new alloys are treated with acids to produce a fairly non-corrodible surface. Aging processes are advisable, and purchasers should receive full instructions as to use and be informed also as to the date when the goods were cast and after what period they might safely be mounted. That, of course, might preclude the utilization of hastily ordered parts. One zinc alloy containing 4 per cent of copper, 1 per cent of aluminum and 8 per cent of tin, and particularly the new durolith, the composition of which was not stated, were said to give full satisfaction as to strength, hardness and constancy of dimensions.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Building, Chancery Lane, London, England.

Ammonia Synthesis.—To facilitate the renewal of the catalytic material employed for the synthesis of ammonia, the inner tube containing the catalyst is rigidly secured to the removable head of the permanently fixed outer pressure tube. The inner tube *T* containing the catalytic material *G* is mounted on the exit tube *L*, which passes centrally through the screwed head *D* of the pressure tube *H*. By unscrewing the head *D*, the inner tube *T* is withdrawn and can be refilled, after removal of the gage plug; or else the whole combination *T D* may be immediately replaced by another in which the catalytic material has already been "formed," preferably by means of the pressure hydrogen issuing from the last catalyzing tube of the plant. To insure a firm screw connection between the head *D* and the pressure tube *H*, the head *D* is kept cool by passing the cold entering gases directly through it by orifice *A* and annular conduit *O*, at the same time keeping the hot exit gases out of contact therewith by employing an asbestos lining *M* for the exit tube. The screw-thread on the head *D* may be continuous but is preferably interrupted. The connection *N* between the catalyzing tube and the ammonia liquefier is immersed in cold water. Specification 171,970 and 171,972 are referred to. (Br. Pat. 174,041. Not yet accepted. Soc. Anon. pour l'Etude et l'Exploitation des Procédés G. Claude, Paris. March 8, 1922.)



Artificial Silk, Fire and Water Proofing.—So-called "staple fiber" which is obtained by cutting up filaments prepared from cellulose solution, etc., is rendered nonflammable by treating the formed filaments at a stage prior to the cutting up with fireproofing solutions such as are ordinarily employed in fireproofing textile materials. The treatment may be carried out after the usual drying process, or in the case of viscose filaments optionally while the filaments are in the gel condition, or in the case of nitrocellulose filaments immediately after the denitration. According to examples, sodium tungstate is deposited on the filaments by treatment with a solution of this salt in acetic acid, and aluminum tungstate by treatment with a solution of aluminum acetate and sodium tungstate in acetic acid. To waterproof the threads, an excess of aluminum acetate may be employed in the second case, or formaldehyde may be added to the bath; or the threads may be treated subsequently with formaldehyde. (Br. Pat. 175,746. W. P. Dreaper, London. April 20, 1922.)

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Process for Producing Alumina and Potash.—Harry P. Bossett uses the following illustration of his patented process: Feldspar, or any other silicate of alum and potash compound, is ground to 100 mesh and heated with excess sodium carbonate and enough sodium sulphate to take care of the potassium. Soluble potassium sulphate and sodium silicate are leached from the insoluble sodium aluminum silicate. Sodium silicate is removed from solution with lime and the potassium salt separated by evaporation. The insoluble silicate is treated with caustic soda, together with lime, to replace sodium and iron oxide to replace aluminum in the silicate. Solution of sodium aluminate is boiled, agitated, filtered and the precipitate of $Al(OH)_3$ is dried. This gives very pure products, according to the claims. (1,410,642; March 28, 1922.)

Crude Petroleum Distillation.—In order to obtain from crude petroleum oil a maximum yield of valuable products, it is generally required that the oil be distilled to the point of dryness—that is, until the residue of distillation is petroleum coke. Offsetting the higher yield of valuable products obtained in this fashion, however, there are attendant disadvantages, which become more and more serious as the specific gravity of the crude oil increases. Thus, in a case of the ordinary quality of Mexican crude petroleum now produced and having a Baumé gravity of from 21 to 23 deg., there is obtained a coke residue very high in sulphur and amounting to as much as 14 to 18 per cent of the weight of the crude distilled with an accompanying gas loss of 2 to 5 per cent. Under many conditions this coke residue may be worth less than the cost of removing it from the stills.

Many of the large refiners, therefore, prefer merely to "skim" the ordinary grade of Mexican crude petroleum—that is, distill off only about 15 per cent—which is less than the total content of naphtha and refined oil, marketing the whole of the 85 per cent residue as a low-grade fuel oil. Aside from the waste of the valuable lubricant fractions and wax of the crude oil inherent in the use of this skimming process, there is a further disadvantageous result of considerable economic importance. This is the failure to produce a supply of a heavy petroleum oil satisfactory for use in the more highly developed cracking processes for the production of gasoline or naphtha. One reason this reduced Mexican crude is unsatisfactory in most cracking processes is that the accumulation of carbon in the cracking stills is so rapid that the amount of gasoline which can be produced before cleaning is required is cut to a very small figure. The present invention, however, provides a method of obtaining from crude oil, and particularly from heavy asphaltic-base crudes, such as Mexican, a maximum yield of valuable hydrocarbons, including heavy hydrocarbons suitable for use as a charging stock in cracking stills, without encountering any of the difficulties met with in the usual process of running such crude down to coke. In brief, the present process contemplates arresting the distillation at the point where the crude oil is reduced to a high-melting-point pitch, and then fluxing this pitch with a quantity of fuel oil sufficient to produce a product which is fluid at ordinary temperatures and capable of being marketed as a liquid fuel product. (1,413,260; Edgar M. Clark, assignor to the Standard Oil Co. of New York; April 18, 1922.)

Technical News of the Week

Current Events in the Chemical, Metallurgical and Allied Industrial Fields—Legislative Developments—Activities of Government Bureaus, Technical Societies and Trade Associations

Bakelite, Redmanol and Condensite Companies Merge to Form Bakelite Corporation

The Bakelite Corporation has taken over the General Bakelite Co., the Condensite Co. of America and the Redmanol Chemical Products Co.

The merger is the result of a suit for infringement of the Bakelite patents brought against one of the customers of the Redmanol company, the General Insulate Co. of Brooklyn. This suit resulted in an unqualified victory for the Bakelite company and the entry of a decree in the United States District Court for the Eastern District of New York on May 11.

The Bakelite patents which are thus broadly sustained cover the molding in general of phenolic condensation products by heat and pressure and the use in such products of fibrous bodies such as wood flour, asbestos, etc. In a previous suit against George J. Nicholas & Co. the Bakelite patents covering the manufacture of varnishes and solutions had been broadly sustained.

The decision against the General Insulate Co. and the bringing of other suits against Redmanol customers made it impracticable for the Redmanol company to continue its business and in order that the value of the good will, plant and organization might not be lost, it was decided to consolidate its business, including the personnel, with that of the General Bakelite Co. The Redmanol company owns a controlling interest in the Condensite company, so the inclusion of that company in the merger was possible. The Condensite company had been operating under the Bakelite patents for several years, paying royalties as the result of suit against it in 1913.

In many respects the products of the three companies are not identical; each supplements the others in important particulars. Thus formaldehyde and "hexa" are made only by Redmanol; galalith is made only by Redmanol; chlorine substitution products are made only by Condensite and transparent material is made by Bakelite and Redmanol but not by Condensite. Their phenolic condensation products also differ somewhat in their method of manufacture.

The three companies entering the merger will continue separately to manufacture and market their products, which are well known under the names of Bakelite, Condensite and Redmanol; these have found wide applications in the radio field, the automotive and electrical industries and for a large number of mechanical uses. As a result of the merger much new development and research work is already under way, from which in due course the industries using these products will greatly benefit.

L. H. Baekeland is the president of the new Bakelite Corporation, with Philip Schleussner, A. Karpen and Kirk Brown vice-presidents, the latter being also general manager. Dr. Baekeland remains also president of the General Bakelite Co., Kirk Brown president of the Condensite Co. of America and Dr. L. V. Redman president of the Redmanol Chemical Products Co.

Federal Specifications Board Forms Metals Committee

The Federal Specifications Board has organized a metals committee. G. K. Burgess, head of the Metallurgical Division of the Bureau of Standards, has been elected as chairman. The committee is to take up the following subjects in the order named: Ingots, castings, wrought metal and chains. The committee recommends that the methods of chemical analysis adopted by the American Society of Testing Materials be used for government check analyses.

Passage of Bill Providing for Helium Conservation and Development Urged by Secretary Fall

The Secretary of the Interior has given his unqualified indorsement to the bill recently introduced by Representative Kahn, chairman of the Military Affairs Committee, providing for the conservation of helium gas. Not only does he approve the bill but he urges "as a matter vital to the best interests of the country" that the bill be passed.

In his letter to Representative Sinnott, chairman of the Public Lands Committee, which has jurisdiction, Secretary Fall points out that we are in the fortunate position of having practically a natural monopoly of helium—an exceedingly valuable asset which should not under any circumstances be dissipated. He also points out that he has submitted the bill to the President and that the Chief Executive also strongly indorses the measure.

Secretary Fall points out that no commercial companies have attempted to separate helium from natural gas. For that reason the needs of the army and navy must be supplied by the government. He calls attention to the fact that of the $5,000,000 asked, $4,000,000 is needed for conservation and $1,000,000 for drilling wells, the necessary pipe lines and the construction of the plant on or adjacent to the gas field, which it is proposed to purchase, for the purpose of processing such amounts as may be necessary to supply the helium requirements of the army and navy. He mentions that the $4,000,000 for conservation is but a temporary outlay, as it is contemplated that the entire amount will be returned to the government through the ultimate sale of natural gas from the lands the purchase of which is under consideration.

The investigations of the Bureau of Mines have shown conclusively, Secretary Fall states, that helium can be conserved most effectively by holding the helium-bearing gas under ground.

With reference to the construction of a new extraction plant, Secretary Fall refers to the progress which has been made possible by the cryogenic research laboratory and the extensive development work which has led to great efficiencies resulting in decreased costs. There is every reasonable assurance, he says, that a plant for the extraction of helium now can be constructed in which both the initial cost and the cost of operation will be much reduced. Another economy would be effected by the bill, since it places all of the work under one department. Heretofore the work has been divided among the War, Navy and Interior departments.

Ominous Calm in Coal Strike Situation as Government Watches for Settlement

All directly interested in the coal strike seem to have paused, seeming to sense that something is about to happen. The quarter from which the break is likely to come does not seem to be indicated. The production of coal is climbing slowly. The country is coasting on its stocks to the extent of two or three million tons a week. The larger consumers are still very well supplied with coal, but some distress is being reported from smaller plants in the regions distant from the non-union fields. The Administration does not believe that the time has been reached when it should force a settlement. Every opportunity should be given, it is stated in Administration circles, for the parties to the strike to reach a settlement uncoerced. It is very evident, however, that there will be no hesitancy to call upon the parties to the strike to arbitrate their differences whenever the point is reached where additional coal production is essential to the public welfare.

Technical Photographic and Microscopical Society Holds Luncheon-Meeting in New York

Strikingly representative of the chemical and allied industries was the gathering of about fifty members and guests of the Technical Photographic and Microscopical Society at the luncheon-meeting of the organization at the Hotel Astor, New York, on June 14. Although the society was organized only 2 months ago, a great deal of interest in its activities and plans has been manifested by individuals and companies using photography and photomicrography in the solution of their research problems.

The incidents and events which led to the formation of the society were described by John H. Graff, its vice-president. Mr. Graff described some of the unique and valuable work that is being done today with the aid of photography. He urged that the society plan an exhibition of technical and industrial photography which will cover all the fields of its application. He remarked that great credit is due to the commercial photographer in developing the technique of the art to its present place and hoped that the society would co-operate with the commercial photographer to the mutual advantage of both.

C. E. K. Mees, of the Eastman Kodak Co., pointed out that the problems of technical photography and photomicrography are distinct in the art and said he therefore welcomed the advent of the society and predicted that through its activities it would accomplish much toward the improvement and progress of photography. He described several of the unusual and interesting problems that have been presented to the Eastman company by technical and scientific workers. Among these were requests for special emulsions for astronomical observations and other highly scientific purposes. He described the research work done in the laboratories of his company to supply these special needs, and added that although the work did not always hold prospects of immediate profit, it frequently paid richly by the newly created field.

Miss Susan B. Leiter, microscopist for the General Electric Co. at its research laboratory in New York, spoke of the extremely interesting problems that fall to the lot of her laboratory. Often, she said, problems which are beyond the scope of any of the other research departments come to her for solution, and frequently the microscope proves equal to the task. Examples of unusual problems described were those of determining the reason for failure on insulation by photographing the ends of the fibers through the microscope and of photographing the inside surface of electric lamp bulbs.

Henry Green, of the New Jersey Zinc Co., Palmerton, Pa., described the photomicrographic laboratory of that company and its work on pigments. He told of the work that is being done in his laboratory in measuring the grain size of pigments. In studying the suspension of carbon in rubber, it is necessary to use a film of rubber $\frac{1}{2}$ micron thick so that it will transmit light. A remarkable degree of accuracy has been attained in this work. The so-called superfine zinc oxide is composed of grains of $\frac{1}{10}$ micron diameter, finer than the particles composing tobacco smoke, which are being measured and studied by photomicrography.

A business session followed, during which the constitution and bylaws were adopted and steps taken to arrange for the exhibit which is to be given at the National Exposition of Chemical Industries in September. The next meeting of the society will be held in conjunction with the exposition. The following committee was appointed to arrange for the exhibit: General chairmen; J. McDowell, New England Section; A. E. Buchanan, New York Section; Textiles, New York Section—W. O. Jelleme, K. B. Cook, B. H. Foster; textiles, New England Section—R. T. Fisher, E. D. Walen, F. L. Babcock, Grimshaw; paper—J. H. Graff, D. A. Smith, T. J. Keenan; photography—J. A. Lucas, C. E. K. Mees, F. F. Renwick, A. B. Hitchins; microscopy—S. B. Leiter, E. J. Wall; metallurgy—H. Green, A. E. Buchanan, G. Hiers; leather—J. A. Wilson, M. W. Cohen; rubber—K. B. Cook, B. H. Foster; testing laboratories—H. B. Gordon, Wehmer; explosives—B. Grotta; apparatus—Scheik; microchemistry—E. M. Chamot, H. Green, A. Zimmerli.

Opinions in House Differ on Muscle Shoals Offers and Construction of Dam

Agreement among the conferees on the War Department appropriation bill to provide $7,500,000 for the reopening of construction work on the Wilson dam at Muscle Shoals probably will be advanced as a reason why an immediate vote should not be taken on the acceptance of Henry Ford's offer for the government's Muscle Shoals properties. Since several years will be required to complete the dam, the steering committee in the House and the majority leaders of that body are expected to take the position that there is little to gain in rushing to a vote on the McKenzie bill. On the other hand, the supporters of the McKenzie and Wright bills will argue that there are great advantages to the public in tendering the property to Henry Ford—advantages which may be lost through the withdrawal of the offer if there be extended delay.

A statement to the effect that the President is opposed to a vote on the McKenzie bill at this time, which was published widely, was denied emphatically on the floor of the House by Majority Leader Mondell. He declared that the President had expressed no opinion as to the disposition of Muscle Shoals and that the majority leaders had not reached any conclusion as to the action they might take in regard to it. Enough is known of their views, however, to make the assumption general that they will oppose a vote on the McKenzie bill. On the other hand, there are enough friends of the Ford proposition, counting those who favor the offer minus the Gorgas steam plant, to constitute a formidable force. It is entirely within the range of possibility that they may be able to force a vote on the matter.

The Wright and McKenzie Bills

The McKenzie bill would make it mandatory upon the Secretary of War to sell and lease to Henry Ford the various Muscle Shoals properties and rights of the government. It excludes from any offer the government's equity in the steam plant on the Warrior River at Gorgas. Arrangements are being made to circulate a petition among members of the House asking for the consideration of the bill. If the signature of a majority of the members of the House can be obtained, it would make it very embarrassing for the leaders to refuse to permit consideration of the bill. In view of the fact that the House now is marking time, awaiting Senate action on the tariff bill and other measures, the chances favor success in obtaining consideration of the measure.

The eight members of the Military Affairs Committee who signed the principal minority report have reserved the right to amend the McKenzie bill so that it will include the government's interest in the Gorgas steam plant. While a bill introduced by Representative Wright of Georgia embodies the exact views of the minority, the fight will be on the McKenzie bill, introduced at the instance of the majority, which can be amended, if sufficient strength can be mustered, so as to express the views of the minority of the committee.

The Majority and Minority Opinions

It is very apparent from the report made by the majority of the committee that those members believe Mr. Ford will take over the properties if they were offered to him definitely, even were the Gorgas plant eliminated. The minority contends that the elimination of the Gorgas plant is equivalent to a rejection of the Ford offer. The minority questions the sincerity of the Alabama Power Co. in offering $2,500,000 for the Gorgas plant, but even if that amount could be obtained for it, it should not be permitted, these members say, to stand between the public and the great advantages which would accrue to it through the acceptance of the Ford offer.

"The money consideration," the majority states in commenting on the offer of Mr. Ford, "is not the vital one. If that were all, the committee would not have spent 2 hours in the consideration of the matter. It is the continuing considerations to be performed by Mr. Ford and his company over a long period of 100 years which give to his proposal its merit."

Thirteenth Annual Convention of the American Oil Chemists Society

The American Oil Chemists held their annual convention this year at New Orleans, in the Grunewald Hotel, June 5 and 6. Although only fifty-two members were present, the small attendance did not interfere with the success of the meeting. Many of the activities of the society are closely related to the work of the Interstate Cottonseed Crushers Association, and much of the time of the convention was taken up with the discussion of committee reports and papers relating directly to the chemical control of the vegetable oil industry.

The reports of the various committees were distributed in printed form, and as these had nearly all been previously published in *The Cotton Oil Press*, little time was lost in acting on their recommendations.

President's Address

C. B. Cluff, chief chemist of the American Cotton Oil Co., in his presidential address spoke feelingly of the society's loss in the deaths of Dr. F. N. Smalley and Dr. Charles Baskerville. In Mr. Cluff's opinion the fact that the membership of the organization had increased in spite of hard times was an indication of its growing strength. It had not been necessary to raise the membership dues, as seemed probable a year ago, largely because of this increase in members.

The most important matter which had come before the governing committee was the question of incorporation. This was later discussed in the convention meeting, and the officers, including the editor, were authorized to sign the charter papers for incorporation under the laws of the State of Louisiana.

The activities of the society are such as bring the officers in direct business contact with members and outsiders and may at any time result in the necessity of defending a suit. Any member of a non-incorporated society, which is legally a partnership, is liable for judgments against the society, but when the organization is incorporated, individual responsibility ceases, and for this reason it was thought advisable to incorporate.

Committee Reports

Dr. David Wesson, technical director of the Southern Cotton Oil Co., as chairman of the referee board, reported on the certification of individual chemists and firms as qualified for arbitration work. He recommended that in the future no certificates be issued to analysts connected with manufacturing concerns, as they were not eligible to act in arbitrations.

The report of the editor of the Chemists' Section of *The Cotton Oil Press*, by Herbert Bailey, chief chemist of the Southern Cotton Oil Co., recommended that suitable reprints of original articles be furnished the authors, free if possible, and if not, at cost. As the Chemists' Section was becoming better known as a medium through which to reach a large number of chemists interested in fats, oils and oil products, it is now easier to secure high-grade articles with which to fill its pages.

The color of oil and meal committee's report was presented, in the form of a paper illustrated with lantern slides, by Dr. Wesson, the chairman. He exhibited the E K. colorimeter, which has been developed by the Eastman Kodak Co., and discussed its advantages and disadvantages over the present Lovibond glasses for the grading of color of oils. This instrument has three gelatine wedges—a red, a yellow and a neutral tint—which may be superimposed in one half of the optical field. The other half is colored by light passing through a standard column of the oil to be graded.

Photographs and diagrams of another color instrument now being perfected by Carl Keuffel, of the Keuffel & Esser Co., were thrown on the screen. This apparatus is not a color comparator, but rather a color analyzer or spectrophotometer. With it the color of a sample would be analyzed rather than compared with an arbitrary standard.

Dr. Wesson showed numerous color-absorption curves made by Mr. Keuffel on oils and Lovibond glasses. One especially interesting point brought out was that with this instrument it was possible to say whether or not a cottonseed oil had been treated with fullers earth and also when a given prime summer yellow oil was bleachable.

H. P. Trevithick, chief chemist of the New York Produce Exchange, reported for the bleach test and fullers earth committee that it had done a little work looking toward the standardization of the official method for making a bleach test. It was decided that next year's committee be instructed to study various mechanical agitators in connection with the test, and if possible recommend a standard type of paddle and rate of stirring.

The oil extraction committee recommended a change in the type of container for meal samples. Dr. Felix Paquin, the chairman, said he had obtained satisfactory results by using a regular paper thimble with a cone of filter paper either outside or inside of it. He also stressed the necessity of weighing the flask before and after the extraction, under identical conditions, and suggested that the time of extraction be increased to 4 hours.

Methods for Cotton Seed Analysis

D. C. Pickard, in his report on methods for cotton seed analysis, discussed the large amount of work done by his committee on three methods (the Smalley-Copes, Pickard and Malowan) for determining the percentage of oil (gasoline extract) and ammonia in seed. The first two of these use only a 5-g. sample, while in the Malowan procedure 25 g. are taken. The agreement of chemists using the first two methods is about 0.60 per cent when the average of three determinations is taken, but the difference between individual determinations made by the same chemists may be over 1 per cent. For large samples the Malowan method is to be recommended.

In the absence of H. C. Moore, chemist of Armour Fertilizer Works, who is chairman of the ammonia committee, his printed report[1] was received and the specific recommendations considered. The c.p. sodium carbonate and ammonium sulphate which the society is now selling as basic standards for ammonia work he believes should be made official standards. Discussing the ammonia results on thirty samples of meals analyzed by eighty-eight collaborators, Mr. Moore's report points out that on the first set of ten samples one chemist did not miss the accepted average more than 0.04 per cent NH_3 on any sample, a second only 0.05 per cent, the third and fourth 0.06 per cent. In the other two groups of ten samples each the maximum variation of the analyst coming closest to the accepted average was 0.03 per cent NH_3 in each group. On the third group of samples four men came within 0.03 per cent or less of the actual NH_3 content of every meal as calculated from the reports of eighty-eight chemists.

Work of Oil Constants Committee

Dr. George S. Jamieson, chemist in charge of the oil, fat and wax laboratory of the U. S. Bureau of Chemistry, reported the results of the analysis of twenty-two samples of authentic peanut oils collected during the past 3 years. This is the work of the oil constants committee, of which Dr. Jamieson is chairman.

The society's co-operative analytical program has been carried on, since the death of Dr. F. N. Smalley, by Herbert Bailey. His report[2] was not read, but the continuance of the work was fully discussed and finally referred to the governing committee. The committee has since arranged that next year only thirty meal samples be distributed and only three certificates and the loving cup be awarded. The compilation of results and all details, except the preparation and distribution of samples, will be in the hands of the ammonia committee. The samples of crude oils for refining tests, and of fats for determination of iodine number and titer, will be distributed by J. H. Morrison, chemical director of the Procter & Gamble Co. His committee will also tabulate the results as reported and handle all details of this work.

Mr. Bailey's recommendation that in the future the co-

[1] *Cotton Oil Press*, vol. 6, No. 1, p. 46.
[2] *Cotton Oil Press*, vol. 6, No. 1, p. 36.

operative analytical program be known as the Smalley Foundation, in honor of the late Dr. Smalley, who had so unselfishly given a great deal of time and energy to this work, was unanimously approved.

R. H. Fash, vice-president of the Fort Worth Laboratories, as chairman of the refining test committee, submitted brief reports by W. G. McLeod, of Morris & Co., on corn-oil refining, and on coconut oil by A. Porter Lee, New York Produce Exchange, in addition to the cottonseed oil report by J. H. Morrison, previously published.[2] The year's work on corn-oil refining covered a comparison of results obtained with straight and curved paddle agitators and uniform stirring speed versus a slowing down of the agitation after the break. So far as the few results reported go, variations in paddles and stirring procedure have no appreciable effect on refining losses.

Mr. Lee stated that in studying the effect of varying the concentration of caustic soda solution on the refining loss of coconut oils, he had observed in some oils a material which was neither meal nor hull fiber. This varied from 0.01 to 0.1 per cent in different oils and seemed to be a partly waxlike body and partly a water-soluble gum.

Co-operation With the Government and Research Institutions

During the past year a committee of the Oil Chemists Society, of which Dr. J. H. Shrader, director of the Bureau of Chemistry and Food, Baltimore City, is chairman, and a similar committee from the Interstate Cottonseed Crushers Association, Edward Barrow, of Barrow-Agee Laboratories, Memphis, chairman, have worked together in co-operation with the government on basic research problems. Dr. Shrader's report outlines four problems already accepted by the U. S. Department of Agriculture for investigation: (*a*) Breeding cotton seed to increase oil content; (*b*) crude oil investigations; (*c*) rancidity investigation, and (*d*) cottonseed meal investigations. Mr. Barrow reviewed briefly the progress already made by Dr. Jamieson on crude cottonseed oil, and offered resolutions of appreciation to the Secretary of Agriculture for his interest and valuable assistance in the solution of problems of the vegetable oil industries. Two papers, one by Dr. Wesson and one by Dr. Jamieson, were read in connection with this work. The former will be published in a subsequent issue of this magazine.

Determining Neutral Oils

Dr. Jamieson, in the course of his remarks, made the following statements:

> Every chemist who applies the official refining test to crude vegetable oils often wonders why there is not more of a proportional relation between the refining loss and the percentage of free fatty acids. The reason in most cases is not that the crude oil with the high loss and low acidity contains more impurities and less oil than the oil with low loss and higher acidity. The reason is inherent in the test.
>
> It is possible, however, to determine, among other things, the absolute amount of neutral oil in the crude. When a crude vegetable oil, dissolved in petroleum ether, is shaken with a large excess of an aqueous potassium hydroxide solution, the free fatty acids are neutralized, the coloring matter is precipitated and certain compounds of fatty acids other than glycerides are decomposed. Addition of a considerable quantity of 50 per cent alcohol causes the mixture to separate into two layers upon standing, an upper clean petroleum ether solution of refined oil and a lower alcohol alkali layer containing the saponified fatty acids, the coloring matter, more or less precipitated matter and other impurities.
>
> This treatment does not decompose fatty acid glycerides. When the method was applied to absolutely dry and neutral refined oils, 100 per cent recovery of neutral oil was obtained. When applied to commercially refined cottonseed oil, a refining loss amounting to 0.20 to 0.22 per cent resulted.

Award of Certificates and Presentation of Cup

Following his report as chairman of the co-operative analytical program, Mr. Bailey awarded in behalf of the society a number of certificates for proficiency in the analyses of oils, fats, meals and fertilizers. The winners of these certificates were chemists who had excelled all other contestants in the co-operative work. Later, at the banquet, he also presented to Dr. H. B. Battle the silver loving cup which is annually given to the chemist who had the highest standing in the check meal work. In connection with this presentation Mr. Bailey paid tribute to the late Dr. Smalley, stating that in his opinion the greatest good accomplished by the society for the chemists in the oil industry was that resulting from the check meal work. Dr. Smalley, with his wonderful far-sightedness, had seen the advantages which would be obtained if all the chemists of

Photo by Edmonston, Washington, D. C.

L. M. TOLMAN, CHIEF CHEMIST, WILSON & CO., CHICAGO, AND NEWLY ELECTED PRESIDENT OF AMERICAN OIL CHEMISTS SOCIETY

the society would analyze every week a portion of a uniform sample of some oil-bearing material. He had given an immense amount of time and thought to the details of this analytical contest and the increase in accuracy as indicated by the results reported each successive year was evidence of the great good which had been accomplished.

Election of Officers

Election of officers for the ensuing year, held during the closing day of the convention, resulted in the following new officers:

President, L. M. Tolman, chief chemist, Wilson & Co., Chicago; vice-president, Dr. H. B. Battle, the Battle Laboratories, Montgomery, Ala.; secretary-treasurer, Thomas B. Caldwell, Law & Co., Wilmington, N. C. Later, at the meeting of the governing board, Herbert S. Bailey was re-elected editor of the Chemists Section of *The Cotton Oil Press*.

The convention was concluded on Tuesday night when the members of the society, the New Orleans Section of the American Chemical Society, their wives and friends enjoyed a delightful banquet at the New Orleans Yacht Club. Following the dinner, Mr. Tolman, the newly elected president, acting as toastmaster, introduced a number of speakers, including several of the past presidents as well as the newly elected officers of the society.

[2] *Loc. cit.* p. 49.

Dedication of State Ceramic Building at Rutgers—Dean of Ceramic Industry Honored

Tuesday, June 13, was not only a history-making day in the ceramic industry in New Jersey, but one of memorable record for the entire field of ceramics in all parts of the country. Through a culmination of events, on this day there was dedicated the finest ceramics building, school and research station of which the industry can boast and signal honor was accorded to the dean of this profession, through the conferring of the degree of Doctor of Science by Rutgers College, New Brunswick, N. J., at its one hundred and fifty-sixth commencement year.

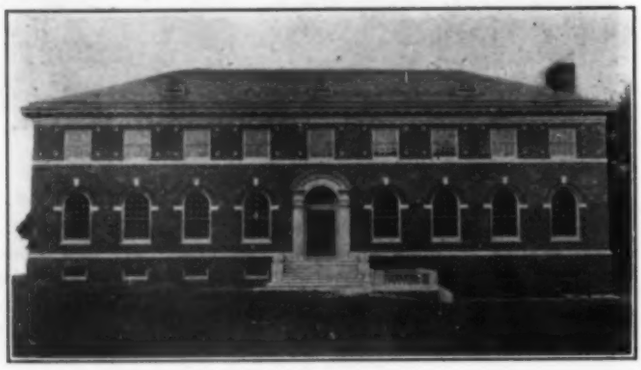
To Edward Orton, Jr., Columbus, Ohio, formerly of Ohio State University, fell the privilege and honor of being the first ceramic engineer ever honored with a degree in this country. It was conferred by W. H. S. Demarest, president of the institution, during the commencement exercises at the morning session, in "recognition of ability and achievements, particularly in the line of ceramic research work for the State of Ohio, and as a director of the first college of ceramics in this country."

As an associate for this honor, Dr. Orton was preceded by Thomas A. Edison, who received a similar degree.

In commenting upon the honor conferred, Dr. Orton said at the alumni luncheon following that he deemed it not as a personal gift or achievement, but rather as a mark of recognition for the ceramic industry that would go to inspire his fellow workers in the craft, as well as the young men coming along who might be considering the ceramic field as one of their choice for the future.

Dedication of Ceramics Building

Located on the Neilson Campus, on line with the chemistry building and Ballantine gymnasium at the institution, the new ceramics building, shown in the accompanying illustration, has been in course of construction for about a year past. The structure was made possible by a state appropriation of $100,000, to which has been added at least $25,000 in contributions from companies and individuals in the industry in the state, embracing both funds and materials. In all, more than eighty companies contributed to make the new building a success.



NEW CERAMICS BUILDING, RUTGERS COLLEGE

The occasion of the official dedication was fittingly arranged for 3 p.m., and faced by an assemblage of more than 150 persons, President Demarest opened the ceremony with a few appropriate remarks. He said that the dedication commemorated the twentieth anniversary of the ceramics department at Rutgers College, and that the fulfillment of the desire for a suitable structure to represent this branch of learning was not only due to the state, but to the energy and untiring efforts of prominent members of the New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society.

Principal Address by LeRoy H. Minton

The principal address was made by LeRoy H. Minton, president of the New Jersey Clay Workers' Association. He said that in outlining the work of the organization in connection with the new structure the industries of the state were divided roughly into nine groups. These included the sanitary ware manufacturers, embracing porcelain and chemical stoneware materials; electrical porcelain manufacturers; terra cotta manufacturers; brick and fireproofing manufacturers; firebrick and refractory manufacturers; floor and wall tile manufacturers; general ware manufacturers; sand and gravel producers. He commented upon the work of Prof. George H. Brown, director of the department and secretary of the association, and said that the building would stand always as a monument to his work.

Other Speakers

Former Senator Thomas A. Brown, who was instrumental in having the appropriation bill for the ceramic building pass the state legislature and receive the Governor's approval, spoke about the value of the institution to the state and its significance to the younger generation coming forward in the ceramic industry.

He was followed by Frank H. Riddle, president of the American Ceramic Society, who made a brief address of congratulation to men in the clay-working industry in the state in achieving their aims in the completion of the new building, and its immediate utility for research and students.

Dr. Orton Pays Tribute to Pioneers

Edward Orton, Jr., the last speaker on the program, traced the growth of the ceramic industry in this country from 1883 when, as a college student, he was given the task of preparing a chapter upon the clays and clay-working industries of Ohio for a volume on economic geology that was to be issued by the state. He paid high tribute to the small group of men who in 1894 approved his plan for the establishment of the first technical school for the clay workers in America. Among these he mentioned Ernest Mayer and F. W. Walker, Beaver Falls, Pa.; Homer Laughlin, East Liverpool, Ohio; Stanley G. Burt, Cincinnati, Ohio; Charles A. Bloomfield, Metuchen, N. J.; A. O. Jones and R. C. Burton, Zanesville, Ohio.

In conclusion he said: "Has ceramic engineering made a permanent place for itself in the field of permanent education? That question may be answered by another, What is permanent? Nothing is permanent in nature—all is in a state of flux. But, with the constantly increasing substitution of the products of the forests by the great group of silicate products, ministering increasingly to the needs of man and requiring with the passing of the decades and centuries always a more critical conservation of thermal energy and greater economy of human labor, we can be sure that they will require trained direction in increasing proportion. Courses of study and names of subjects will change, but that technical schools will cease to produce that kind of educated leadership which we now know as the ceramic engineer is not thinkable."

The Ceramics Building

The new ceramics building is 45x102 ft., of fireproof construction throughout, two-story and basement. The exterior is of red brick, with buff terra cotta trimming, including a base course at the first floor, a stringer course around the second floor, and terra cotta cornice. Terra cotta medallions, depicting certain branches of the clay-working industry, later will be inserted between the windows at the tops and there will be a terra cotta doorway at each entrance. The interior walls of the structure are of common brick, with hollow tile ceilings and floors throughout.

The basement comprises physical testing room, brick machinery room, sagger and plaster shops and miscellaneous operating departments.

The first floor contains a pottery laboratory, pottery storeroom and ceramic materials laboratory. A stairway leads from the pottery laboratory to the kiln room. At one end of the first floor there is a class room and four research laboratories.

The second floor is arranged with offices, library, drafting room, chemical laboratory and at one end, a museum or assembly room extending across the entire end. This

room, 25x42 ft., is finished throughout with tile, including a red tile floor, tile paneling and inserts around the ceiling, with tile fireplace and mantel.

Summer Meeting of New Jersey Clayworkers' Association

To permit visiting ceramists from different parts of the country to be present at the regular summer meeting of the New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society, this gathering was arranged on the day following, Wednesday, June 14, at the Country Club, Trenton, N. J.

The opening address was a paper by LeRoy H. Minton, president of the association, on the subject of the Royal Berlin Porcelain Works, Germany, which he visited on a recent trip abroad. The paper was illustrated with a number of interesting lantern slides. In this line of hard porcelain manufacture, it was pointed out, the principal clay used is the Halle variety, originating from a decomposition of granite rock and mixed abundantly with sand and other materials. The "flow" of operation through the plant was described, including the settling tanks, preparation of body, filter presses, period of aging, drying and firing of bisque ware, glazing and color decorations. Particular reference was made to the different types of kilns installed at the plant, including three-story kilns, each chamber forming an individual operating unit. A chamber kiln of twenty-two compartments is also in service.

Past, Present and Future

Departing from the usual custom of a set program, President Minton said that the time was opportune for comments on the "Past, Present and Future" of the ceramic industry, and he allotted these subjects to Charles A. Bloomfield, A. V. Bleininger and Frank H. Riddle, respectively.

Mr. Bloomfield spoke interestingly of the days gone by, of the obtaining of an appropriation for the first ceramic department at Rutgers College 20 years ago, in which he was instrumental, and of the growth of the ceramic industry and ceramic education up to the present time.

At this point Mr. Bleininger gave a pertinent résumé as to present-day happenings. He said that the trend decidedly was toward research and investigation, of the study of clays in different forms. A more definite understanding of plasticity is being obtained, and of the absorption of gases and liquids. Firing conditions, he pointed out, are still poor, and better kilns must be secured in the days to come; better temperature control is essential and other phases of firing the ware. The investigation of the more obscure phenomena, such as now going on, cannot help but bring about immeasurable benefit and profit.

Frank H. Riddle, of the Champion Porcelain Co., Detroit, Mich., president of the American Ceramic Society, said that the future would show a development of plant control, an amalgamation of plant management and the technical end of the business. The mechanical phases of the ceramic industry also, he said, presented great possibilities, and machinery of improved type for different features of manufacture naturally would come as a result of research and practical investigations. He said that in the years soon to come what are now known as "super-refractories" will be known as normal materials, for the general trend is toward the development of refractories for higher temperatures. Other fluxes, he prophesied, will come into use—materials which are now available but little known. Magnetic separation is another matter offering great possibilities, and one that is destined to receive concerted interest and attention in the future. Tunnel kilns and kilns of other types are open to big improvement, and this will come as the industry advances. Still another subject of importance is the control of gas conditions, so necessary in high temperatures, and this will ensue as a natural order of development. He prophesied that oil-gas producers will come into far more extensive use in the future.

Dr. Edward Orton, Jr., was the next speaker, and he commented extensively upon the new ceramics building and what it meant to the state and to the industry. He pointed out the necessity for getting the right kind of students, and the advantage of actual shop work during the term of technical training. He said that the ceramic manufacturers in the state should co-operate intelligently in selecting bright men from their plants for a course of instruction at the institution.

Ross C. Purdy, secretary of the American Ceramic Society, followed Dr. Orton, and congratulated the association members on their attainments in connection with the new ceramics building. He spoke at length upon the society he represents, and features of research now going on through different committees.

Succeeding speakers were Charles Howell Cook, president of the Cook Pottery Co., Trenton, and August Staudt, head of the Perth Amboy Tile Works, Perth Amboy, N. J., both past presidents of the association.

Chemical Warfare Service Appropriation Urged on Basis of Research Need

Testifying before the Senate Appropriations Committee in support of appropriations for the Chemical Warfare Service, Brigadier-General A. A. Fries, chief of that branch, stressed the importance of continued research on chemical warfare. Whether or not the army uses this weapon, it is important that all information possible be available for defensive measures. He referred to mistakes made in the war by both sides in the use of poison gas, all of which were due to lack of research. He also emphasized the importance of fundamental research in other fields in which the government is directly concerned.

The War Department's estimate as presented to the committee provides 272 combat troops for the Chemical Warfare Service. Senator Hitchcock of Nebraska was moved to ask why there should be combat troops in that branch of the service. General Lassiter, replying for the department, explained that the chemical warfare troops are authorized by law. The department is considering the question of reducing the number to a point necessary to comply with the terms of the treaty. The law calls for 100 officers and 1,200 enlisted men in the Chemical Warfare Service for an army of 280,000 men. The Service now has 87 officers and 550 men.

General Lassiter agreed with the comment of Senator Sutherland that the treaty does not involve the abandonment of all research along chemical warfare lines, interpreting it as providing only against the use of gases in warfare. He stated that the War Department would present a project on the Chemical Warfare Service personnel to Congress later.

Associations to Meet at Chemical Exposition

Several leading associations of the chemical industry have definitely arranged to meet at the Eighth National Exposition of Chemical Industries, which will be held during the week of Sept. 11 to 16 at the Grand Central Palace, New York. The special meetings which have already been scheduled to be held at the Grand Central Palace during the week of the exposition include a meeting of the American Ceramic Society, the Technical Association of the Pulp and Paper Industry and the Salesmen's Association of the American Chemical Industry. Other technical and commercial groups connected with the chemical and allied industries are also expected to meet at the time of the exposition, but definite arrangements for the latter have not as yet been made.

The exposition was purposely scheduled to come between the meeting of the American Chemical Society in Pittsburgh, Sept. 6 to 9, and that of the American Electrochemical Society in Montreal, Sept. 21 to 23, so that September will as usual be a busy month in chemical circles.

Helium Manufacture Described by Moore in England

The English press gave prominent notice to the public lecture delivered at the University College of London on May 24 by R. B. Moore, chief chemist of the U. S. Bureau of Mines. Dr. Moore's topic was "Commercial Manufacture of Helium by the Government of the United States."

Consideration of Dye Embargo in Senate Tariff Discussion Again Delayed

While some delay in taking up the dye embargo feature of the tariff bill has been occasioned by a variety of causes, it can be stated definitely that the effort of its opponents to have it go over until the administrative provisions of the bill are reached has been unsuccessful.

It has been stated that the proponents of the embargo, secure in their position by reason of the indefinite extension of the existing embargo, are unconcerned as to the delays and really are hopeful that the bill itself might be recommitted so that the dye industry could be assured for a considerable time at least of that restriction on imports. Anyone who has had contact with the dye manufacturers who have come to Washington in connection with this legislation is in a position to refute such a charge, as their entire effort has been to obtain the speedy adoption of the bill and the termination of the uncertainty. Senator Frelinghuysen, who is leading the fight to make possible the maintenance and encouragement of the domestic chemical industry, has been almost abrupt on several occasions in demanding that further delay in taking up the question be prevented.

When Senator King was in the midst of a denunciation of what he terms the lobby in the interest of the embargo, Senator Frelinghuysen asked why he did not give some attention to the agents of the German dye interests who seem to have been extended office facilities in the Senate Office Building.

Revise Potash Schedule

Further revision of the potash schedule in the tariff bill has been decided on by the Finance Committee. In place of the proposed duties for 5 years as previously agreed on, the committee has decided to place potash on the free list and substitute for a tariff a bounty to American producers to aid them in producing potash. The change was explained to the Senate by Chairman McCumber of the Finance Committee. He said that Senator Hale of Maine had asked that potash be placed on the free list. The committee tentatively proposes, in lieu of the tariff, to encourage the American industry by granting a bounty equivalent to the tariff rate originally proposed. He stated that if the annual production of potash were 50,000 tons a year, the bounty would amount to not more than $2,500,000 for the first and second years, $2,000,000 for the third year, $1,500,000 for the fourth and $1,000,000 for the fifth year.

Tungsten and Chromium Rates

The Senate adopted a duty of 60c. a pound on the tungsten content and 25 per cent ad valorem on ferrotungsten, metallic tungsten, tungsten powder, tungstic acid and other compounds of tungsten.

During the tariff debate Senator Walsh of Montana inquired why a duty had not been placed on chrome ore. Senator Smoot of Utah explained that it is due to the fact that chrome ore production is scattered and the American product is inferior to the imported. Senator Walsh did not agree, saying there is no limit to the amount of the ore that could be produced and that it is equal in quality to that produced elsewhere.

Shortridge Resolution Would Give President Power to Act on Reparation Dyes

A resolution has been introduced by Senator Shortridge granting broad powers to the President to be used in meeting the reparations dyes situation. Senator Shortridge is chairman of the sub-committee which has just completed its investigation of the dye situation.

The resolution provides that the President be authorized and requested to take such measures as may be required to obtain for the United States the dyestuffs and drugs to which it is entitled under Sec. 1, Art. XI of the treaty of peace between the United States and Germany.

The need for immediate and decisive action in arranging for a satisfactory receiving system for the reparations dyes before June 30, when the present arrangement terminates, was brought out during the investigation.

Summary of Chemical and Oil Companies Organized

During the month of May twenty new companies were organized, with individual capitalization of $50,000 or more, to manufacture chemicals, chemical byproducts, drugs and affiliated products. The aggregate indicated investment was $3,671,000, as compared with $20,055,000 in the preceding month, when exactly the same number of such concerns were formed. During the same month of a year ago the total capitalization of such new companies was $12,400,000.

Seventy-three companies were organized in May with capitalization of $50,000 or more, to engage in different branches of the oil industry, with total indicated investment of $105,595,000.

Personal

Dr. Robert Calvert is now in charge of the Celite Products Co.'s laboratory at Lompoc, Cal.

F. E. Coombs, consulting chemical engineer of San Francisco, Calif., has accepted a position with the Department of Commerce. After some months in Washington he will be stationed in Havana, Cuba.

E. P. Gillan has resigned his position as chief chemist with the American Cereal Syrup Co. to accept one with the Chicago Starch Co.

James B. McNair, chemist with the Bureau of Internal Revenue, has been transferred from Washington, D. C., to Chicago, Ill.

George N. Moore, president of the Shaffer Oil & Refining Co., Chicago, Ill., has resigned. He will become head of a new oil-refining company now being organized.

J. C. Pearson, chief of the cement investigations of the Bureau of Standards, has just returned from a long Western trip. While in California he arranged for the investigation of cement sewer pipe which the bureau is to make during the coming year.

Prof. Charles Hyde Warren has been elected by the Yale Corporation as director of the Sheffield Scientific School to succeed Russell H. Chittenton. Prof. Warren is an alumnus of Yale, class of 1896, and since 1900 has been on the faculty of the Massachusetts Institute of Technology. Since 1915 he has been professor of mineralogy. Dr. Chittenton's retirement follows a determination made when he offered his resignation a year ago. He has been a member of the Yale faculty since his graduation from Sheffield Scientific School 47 years ago has been head of Sheff. since 1898.

Obituary

S. C. Ellis of Dallas, Tex., chemist and bacteriologist, formerly in charge of the municipal laboratory at the City Hall, died on May 31, at San Angelo, Tex., where he had gone on account of poor health. He was 30 years of age, and served 18 months overseas in the World War. Mr. Ellis is survived by his wife and young daughter.

A. H. Kersting, president of the Clinton Sugar Refining Co., Clinton, Iowa, died suddenly at his home on June 1, as a result of a stroke of apoplexy.

Alexander H. Smalley, chief chemist of the Nucoa Butter Co., Bayonne, N. J., died on June 8, as a result of injuries received in an explosion, followed by fire, in the chemical laboratory at the plant on the date noted. He was 25 years of age and a graduate of Cornell University.

E. R. Kemp, chairman of the board of directors, Sinclair Oil & Gas Co., Tulsa, Okla., died on June 9 at Roosevelt Hospital, New York, following an operation for appendicitis. He was 50 years of age, and widely known in the Middle Western oil-refinery industry. Mr. Kemp is survived by his wife and three children.

Market Conditions

IN CHEMICAL, METALLURGICAL AND ALLIED INDUSTRIES

A Survey of the Economic and Commercial Factors That Influence Trade in Chemicals and Related Commodities—Prevailing Prices and Market Letters From Principal Industrial Centers

Studies of Depreciation and Obsolescence Offer a Promising Field for Chemical Trade Associations

Depreciation and obsolescence are stumbling blocks in almost every cost-finding system, but particularly in the chemical industries are their difficulties most evident. The cost accountant in these industries is often confronted with other very serious problems, such as those arising from joint products and byproducts, inter-departmental transfer of materials, off-standard products, etc., and in the maze of these difficulties he is likely to accept without question some very arbitrary method of handling depreciation and obsolescence charges. Or, as is the case with some chemical firms, these items are not regarded as proper elements of current costs and are taken into consideration only at the end of the year or some other fiscal period, when a definite sum is written off against profits to cover depreciation and obsolescence. And very often this amount is influenced by the amount of profits shown on the credit side of the ledger.

A Plan for Group Studies

For tax purposes, however, there is a very definite need for accurate methods of determining these charges and particularly in such a manner as will receive the indorsement of the Treasury Department. In the hope of assisting manufacturers in this connection, the Fabricated Production Department of the Chamber of Commerce of the United States has worked out a plan for handling these problems through the agency of the trade associations within the different industries. The plan provides for the appointment of a committee on depreciation, which should preferably consist of from five to seven engineers, cost accountants and plant superintendents selected from the industry. This committee would prepare a questionnaire providing for the listing of equipment and other units of utility[1], their cost, estimated scrap value and years of useful life.

Before sending this questionnaire to the manufacturers, the department recommends that certain preliminary points, such as the following, should be cleared up:

(*A*) *Method of Charging Maintenance, Renewals and Depreciation.* It will not do merely to average the various estimates of useful life provided by the manufacturers of a given line, because the methods of charging maintenance, renewals and depreciation may not be the same. Thus one manufacturer may charge as maintenance all repairs and partial renewals. By this method the laying of a new roof on a building would be charged as maintenance. Another manufacturer may charge to maintenance only such items as tend to keep the property in the same general condition. The laying of a new roof adds to the life of the asset and accordingly would be charged to the depreciation reserve. The first method gives a high maintenance rate and a low depreciation rate. The second method gives a low maintenance rate and a high depreciation rate. Suppose the first manufacturer charges 2 per cent for depreciation and the second 8 per cent. It will not do to average these rates and set 5 per cent as the guide for the industry. That would not give a true picture of actual conditions.

The Elements of Depreciation

(*B*) *A Statement of the Elements of Depreciation.* Accompanying the questionnaire should be a statement of the elements entering into depreciation, wear and tear, and obsolescence.

Wear and tear is defined as "that uniform wear-out and decay which repairing is unable to check" and it is dependent upon the amount of use, the amount of care, the quality of the installation and the natural hardships to be overcome.

Obsolescence arises from "an inability to compete in kind, in quality or in cost of desired results with later forms of the same utility." Allied there is that change in demand which displaces the whole life of the equipment.

The department points out that it is important for the depreciation committee to obtain sufficient facts for it to come to a conclusion as to which is the factor, obsolescence or wear and tear, determining the useful life of a given unit of utility. Certain chemical equipment is often not given the opportunity to wear out, it is replaced so rapidly because of improvements in the art. Clearly obsolescence is here the determining factor.

(*C*) *Determining Stated Conditions of Use.* Guide rates of depreciation for an industry presuppose stated conditions of use—the number of days of operation in a year, the number of hours of operation per day, a standard of maintenance, external conditions such as climate and road, etc.

With the normal conditions of use stated, it will be possible to provide for variances thereof upon a scale of percentages. Thus during the war additional rates of depreciation were allowed for overtime operation, and when depreciation can be based on an incident of production, capacity or performance, it may be feasible to scale the rate of depreciation for subnormal production.

After these questionnaires have been returned by the manufacturers, the committee is expected to prepare a digest of them, which is submitted to the industry for criticism and comment. Upon revision a conference can be arranged with experts of the Treasury Department in order that the depreciation data may be checked by them. When so checked the rates of depreciation should be promulgated as guide rates for the industry. It should be thoroughly understood, of course, that these depreciation rates would be merely suggestive and not mandatory and that in the last analysis the manufacturer must determine depreciation allowances from his own individual experiences.

Chemical manufacturers wishing to perfect this phase of their cost systems will do well to consult the Fabrication Production Department's very interesting pamphlet on "Depreciation—Its Treatment in Production." More general in character but of equal importance to the chemical industries is the report of the cost accountants' committee of the American Dyes Institute, which was published in 1920 under the title "Uniform Cost-Accounting Methods."

[1] "Unit of utility" is defined by the Treasury Department to mean a single purposed mechanism or part of a construction, subject to such like conditions of use that it would naturally be repaired or replaced as a unit.

CHEMICAL & METALLURGICAL ENGINEERING'S WEIGHTED INDEX OF CHEMICAL PRICES

Base = 100 for the year July 1, 1913, to June 30, 1914

This week	156.89
Last week	157.93

June, 1917	222	June, 1918	272
June, 1920	274	June, 1921	147
April, 1918 (high)	286	April, 1921 (low)	140

During the past month this index number has receded almost 4 points—from the recent high of 160.49 on May 24 to 156.89 for the current quotation. Of the 25 commodities on which this index is based, lower prices were recorded during the past week for 6—viz., formaldehyde, glycerine, potassium carbonate, soda ash, caustic soda and linseed oil.

Organization and Financing of the International Carbon Corporation

A new corporation to be known as the International Carbon Corporation has been organized to acquire control of the Darco Corporation and the patent rights for the manufacture of this decolorizing carbon. The operation of the manufacturing plants of the new corporation is under the direct supervision of the Atlas Powder Co., of Wilmington, Del., and the management of the Darco Sales Corporation is under the direction of the Columbian Carbon Co.

The authorized capitalization of the International Carbon Corporation consists of $2,500,000 of 8 per cent cumulative preferred stock, of which $863,300 is outstanding, and 300,000 shares of no par value common stock, of which 231,000 shares are outstanding.

Darco, the product to be manufactured, is produced from lignite by a patented process. It is used as a substitute for animal charcoal in the refining, decolorizing and deodorizing of a large number of staple products. Included in the list of industries in which decolorizing carbons are already finding use are sugar, glucose, maltose, lactose, sirups, glue, gelatine, vegetable oils (cottonseed oil, corn oil, peanut oil, coconut oil, olive oil, soya bean oil), fish oils, lard and butter substitutes, glycerine, alcohol, acids, wines, pharmaceutical chemicals, dye intermediates and photographic and other synthetic organic chemicals.

A unit producing a ton a day has been in operation for more than a year at Marshall, Tex. It has just been announced that a 4,000 ton per year plant has been constructed and has commenced operation. The plant is adjacent to a large deposit of lignite and it is reported that an ample supply of natural gas is available for fuel.

New Financing for Atlantic Refining

A group of New York bankers, including the Equitable Trust Co. of New York, Cassatt & Co. and Blair & Co., Inc., recently purchased $15,000,000 15-year 5 per cent noncallable gold debentures of the Atlantic Refining Co. On the first day they were offered for sale the issue was largely oversubscribed and the subscription lists have since been closed.

The Atlantic Refining Co., it will be recalled, owns and operates refineries at Philadelphia, Franklin, Pa., Pittsburgh, and Brunswick, Ga., besides owning extensive sales equipment, warehousing and storage facilities throughout Pennsylvania, Delaware and the New England states. Its total deadweight tonnage of tank steamers and various marine equipment is estimated at 75,000 tons. A subsidiary of the Atlantic is interested in the production of crude oil in Mexico.

American Metal Reports Earnings in First Four Months of 1922

Consolidated profit and loss account for the first four months of 1922, according to C. M. Loeb, president of the American Metal Co., Ltd., shows net earnings for that company of $762,708, after allowances have been made for depreciation, etc.

After completing the financing that is now under way, the American Metal Co. will have $5,000,000 preferred stock authorized and outstanding and 536,000 shares of an authorized issue of 1,000,000 shares of common stock having no par value.

The New York Market

NEW YORK, June 19, 1922.

Business during the past week in the chemical market has been generally quiet due to the influence of a number of different elements. The coal strike, the uncertainty of tariff legislation, the possibility of a railroad strike and the failure of the loan negotiations in Europe have combined in causing a general slackening in industry. With the exception of a few commodities, the entire chemical list showed no outstanding features. Flouride of soda and acetate of soda recorded net advances for the week, while prussiate of soda, nitrite of soda, formaldehyde and bleaching powder were quoted lower under keener competition and an abundance of spot stocks. The export inquiry for caustic soda showed considerable improvement and so too did the domestic inquiry.

Crude coal-tar products continue firm and in good demand. Producers of cresylic acid, benzene, solvent naphtha and toluene are experiencing a steady call from the various consuming industries. Intermediates, on the other hand, are quite irregular. Aniline oil, beta naphthol and para nitraniline are much easier under a slackening of demand and are subject to pronounced shading.

INDUSTRIAL CHEMICALS

Ammonium Carbonate—First hands are holding stocks well in hand at 8¾c. per lb., and quote the market on the basis of 8¾@9c. per lb. Second hands offer odd lots at 8¼c.

Arsenic—Prime white powdered material on spot is held firm by leading dealers at 7¼@7½c. per lb. A moderate consuming inquiry is reported, with trading fairly active.

Bichromate of Potash—A few small-lot sales were recorded by resale merchants at 9¾c. per lb. Large quantities were quoted down to 9½c. Business in this product has not shown any appreciable change during the past week.

Bichromate of Soda—Trading is quiet for both export and domestic consumption. Spot goods are quoted at 7¼@7½c. per lb., with a few small resale lots as low as 7¼c. per lb.

Caustic Potash—Business has been moderate during the interval and several sales were reported at 5¾c. per lb. for 88-92 per cent goods. Shipments were quoted around $5.65 per 100 lb.

Caustic Soda—The export market is being strongly maintained at $3.80@$3.85 per 100 lb., f.a.s. Inquiries have been more abundant during the past week and producers are looking forward to a better volume of business. Domestic quotations remain practically unchanged.

Copper Sulphate—The general condition of this market is exceedingly firm, with only a few odd lots available. The demand is very active for spot and near futures, with prices for standard large crystals ranging around 6@6¼c. per lb.

Fluoride of Soda—The market has recorded an advance of 1c. per lb. Leading factors report sales of small quantites to the consuming trade at 10@10½c. per lb. Demand is fairly active.

Nitrite of Soda—Most trading has been done on a small quantity basis, with resale merchants quoting 8¼@8½c. per lb. for imported material. Domestic prices are held around 9c. per lb.

Prussiate of Soda—Demand has eased off considerably and spot prices were much lower. Imported goods was quoted as low as 20½c. per lb. with the prevailing figure at 21½c. per lb. Recent arrivals have had a detrimental effect on the spot market.

Soda Ash—The market for this commodity is reported quiet by leading factors. Light 58 per cent, in single bags, is quoted at $1.80 per 100 lb. in carload lots on spot. Contracts remain unchanged.

Sodium Acetate—The lowest price for spot material is around 5½c. per lb. The demand has shown considerable improvement during the past few weeks and producers report a temporary shortage of spot supplies.

COAL-TAR PRODUCTS

Benzene—Resale material is exceedingly scarce, with a few light offerings of the 90 per cent held around 35@40c. per gal. Producers continue to quote contracts of the 90 per cent at 28@32c. per gal. and the pure at 30@35c.

Cresylic Acid—Resale 97-99 per cent material on spot is quoted as high as 65c. per gal. Several sales were recorded at this level. The general condition of this market is very firm, with offerings limited. Producers are quoting 56@58c. per gal. for the 97-99 per cent and 51@53c. for the 95 per cent, dark, f.o.b. works.

Alpha Naphthol—The refined material sold at $1.10@$1.15 per lb. during the past week. Small lots seemed to feature the market. Technical goods remained dormant, with sellers asking $1@$1.05 per lb.

Beta Naphthol—There has been no improvement in the market for the technical variety and the general condition is very irregulaar. Spot material is quoted around 23c. per lb.

The Iron and Steel Market

PITTSBURGH, June 16, 1922.

The general iron and steel situation underwent no particular change in the past week. Pressure upon the mills for deliveries may have increased a trifle, while the volume of sales and purchases probably decreased slightly. The steel market is not especially active, from a tonnage standpoint, not nearly as active as in April.

The urgency of steel buyers for deliveries is probably not a measure of their immediate requirements, but rather represents anxiety lest something occur to prevent shipment later, such as a decrease in steel production due to the coal strike. There is no evidence that any consumers of steel are really short of steel or are having their operations restricted on this account.

HAS THERE BEEN AN ACCUMULATION OF STOCKS?

As to the general position of the steel market, its strength and its prospects for the nearby future, the discussion still centers around the question of how much steel buyers have accumulated. Production in the past 3½ months almost equals production in the 6 months preceding. It is pointed out that part of the so-called accumulation of stock is in steel which buyers have gathered together for construction and other work, in accordance with ordinary practice, and this prevents the steel from being considered speculative, or as accumulated merely because there is a coal strike.

While the condition can be explained and defended, the bare fact remains that the steel market is more or less on the defensive—that is, there is a call, admitted to be reasonable, for an explanation of why the market is as strong as it is. Steel ingot production at the present rate, about 39,000,000 tons a year, is 30 per cent in excess of the average rate in the two largest tonnage years before the war, 1912 and 1913, and 55 per cent above the output in the next best year, 1910, yet one could scarcely say that the surface indications are that steel is being actually consumed in the same tonnage as in those years.

THE STEEL MARKET

The steel market has been gradually growing quieter as to tonnage turnover. The trend can be attributed to the increasing unwillingness of mills to obligate themselves farther, as they are well sold up now and the coal strike is not ended, to the disposition of buyers not to commit themselves as far ahead as they used to do, and to the approach of the usually dull midsummer period.

Prices are very firm all along the line, and if prices do not show a general advancing tendency there is at least a little more disposition for early deliveries to command premiums, and there is an advancing tendency in manufactured steel products, such as bolts, rivets, spikes, cold-finished bars, etc., attributed to the higher prices now ruling for the raw materials involved.

The market is quotable as follows: Bars, shapes and plates, 1.60@1.80c.; hoops and bands, 2.25@2.40c.; blue and annealed sheets, 2.40@2.50c.; black sheets, 3.15@3.30c.; galvanized sheets, 4.15@4.30c.; automobile sheets, 4.50@4.75c.; tin plate, $4.75; nails, $2.40@$2.50; standard steel pipe, 71 per cent basing discount.

PIG IRON AND ORE PRICES

The pig iron market continues very dull, and is not quotably changed, as follows: Bessemer and basic, $25; foundry, $24@$25 f.o.b. valley furnaces.

Lake Superior iron ore prices for the 1922 season have been developed at 50c. decline from the 1921 and 1919 prices, or $1.50 under the 1920 schedule. The new prices, f.o.b. Lake Erie docks, are: Old range bessemer, $5.95; old range non-bessemer, $5.20; Mesabi bessemer, $5.70; Mesabi non-bessemer, $5.05. Approximately half the reduction from last year is borne directly by the ore producers, the remainder being in reduced transportation cost. The transportation tax has been off since the beginning of the year, involving a saving of about 5c. a ton. Rail rates from mine to dock have been reduced 10 per cent, equal to 10c. on Vermilion and Mesabi ores, the net lake vessel rate is down 10c. and the Lake Erie dock charge, added to the vessel rate, is down 1c., making the total lake rate 70c. plus 13c., or 83c. This brings the ore to the market prices being in essence at the rail of the vessel, and then there is a reduction in the dock charge from rail to car from 8½c. to 8c., a direct saving to the ore buyer in addition to the 10 per cent reduction in rail rates from Lake Erie which went into effect June 15.

The Chicago Market

CHICAGO, Ill., June 15, 1922.

Firmness characterizes the industrial chemical market, even though sales show no particular increase in volume. Demand continues only routine, although buyers display a little more confidence in the market. Stocks are not generally heavy and it is difficult to locate any supplies at all of some items. Prices are maintained in nearly every direction, even the small broker being reluctant to cut his schedule. Imported material is very firm, with arrivals lighter than usual.

GENERAL CHEMICALS

The alkali market is unchanged, with the movement of supplies fairly active. *Caustic soda* is firm at $3.85@$3.95 per 100 lb. for the solid and $4.35@$4.50 for the ground or flake. *Caustic potash* continued firm, with small lots of the 88-92 per cent material offered at 6¾c. per lb. *Soda ash* is reported to be moving well at $2.20@$2.30 per 100 lb. for the 58 per cent material in cooperage.

Alums are in an easy position, although holders maintained their schedules. *Ammonia alum* is available at 3½@4c. per lb. for the lump and 4@4½c. for the powdered. *Potash alum* is in light demand and lacks quotable change. The lump is quoted at 4½c. per lb. and the powdered at 5½c., the latter grade moving in a somewhat better volume. Barium compounds, while very firm, are in a somewhat easier position. Small lots of *barium chloride* are available at $110@$120 per ton. *Copper sulphate* continues exceedingly firm, with spot stocks light. Small lots were quoted at 6@6½c. per lb. There is a small demand for ammonium carbonate and the lump is available at 13@13½c. per lb. *Sal ammoniac* is moving in a routine way at 7¾@8c. per lb. for the white granular. The lump sal ammoniac was firm at 17@18c. per lb. *White arsenic* is somewhat easier at 8c. per lb. *Carbon bisulphide* is moving slowly at 7@7½c. per lb. for drums. *Carbon tetrachloride* is enjoying a somewhat better demand and is quoted at 10c. per lb. in large drums.

There is little or no change on bichromates, the market presenting an easy appearance. *Potash bichromate* is quoted at 11¾c. in single-cask lots and the *soda* in similar quantities at 9c. *Potash permanganate* is easy, with U.S.P. material available at 16c. per lb. The prussiates continue very firm and scarce, with prices higher on both kinds. *Yellow prussiate of potash* is quite scarce and only small or medium lots can be located at 34@36c. per lb. The *red* remains off of the market, with nothing in sight for future delivery. *Potash chlorate* is moving slowly at 8c. per lb. for the powdered and 9@10c. for the crystals. *Rochelle salts* are in an easy position and imported powder is available at 20c. per lb. *Hyposulphite of soda* is dull at $3.85 per 100 lb. for the pea crystals in barrels.

LINSEED OIL

Linseed oil is moving a great deal more freely and the outlook is brighter. Single drums of the boiled oil are quoted at 98c. per gal and the raw in similar lots at 96c.

NAVAL STORES

Turpentine is none too plentiful, and the local market was very firm. A prominent factor in the market predicts higher prices with increasing scarcity. A good movement is reported at $1.06 per gal., basis single drums. *Rosins* were in a position similar to turpentine and are reported to be moving freely. The WW grade is quoted in less than carlots at $9 per 280 lb.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots F.o.b. N.Y.	Less Carlots F.o.b. N.Y.
Acetic anhydride	lb.	..... –	$0.38 – $0.40
Acetone	lb.	$0 08 – $0 09	.09½ – .10
Acid, acetic, 28 per cent	100 lbs.	2 25 – 2 50	2 55 – 3 00
Acetic, 56 per cent	100 lbs.	5 00 – 5 25	5 30 – 5 50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		8 50 – 9 00	.50 – 9 75
Boric, crystals	lb.	.11 – .11½	.11½ – .12
Boric, powder	lb.	.11 – .11½	.11½ – .12½
Citric	lb.	..... –	.45 – .46
Hydrochloric	100 lb.	1 10 – 1 20	1.25 – 1 70
Hydrofluoric, 52 per cent	lb.	.11 – .11½	.11½ – .12
Lactic, 44 per cent tech	lb.	09½ – .10	.10½ – .12
Lactic, 22 per cent tech	lb.	.04 – .04½	.04½ – .05
Molybdic, c.p.	lb.	3.00 – 3.25	3.30 – 3.75
Muriatic, 20 deg. (see hydrochloric)		..... –	..... – .....
Nitric, 40 deg.	lb.	.06 – .06½	.06½ – .07
Nitric, 42 deg.	lb.	.06½ – .06¾	.07 – .07½
Oxalic, crystals	lb.	.14 – .14½	.14½ – .15
Phosphoric, 50 per cent solution	lb.	.08 – .08½	.08½ – .09½
Picric	lb.	.22 – .24	.24½ – .30
Pyrogallic, resublimed	lb.	..... –	1.65 – 1.75
Sulphuric, 60 deg., tank cars	ton	10 00 – 11 00	..... – .....
Sulphuric, 60 deg., drums	ton	12 00 – 14 00	..... – .....
Sulphuric, 66 deg., tank cars	ton	15 00 – 16 00	..... – .....
Sulphuric, 66 deg., drums	ton	19.00 – 20.00	20 50 – 21 00
Sulphuric, 66 deg., carboys	ton	..... –	..... – .....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	19 50 – 20.00	..... – .....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	22.00 – 22 50	23.00 – 24.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	..... –	.60 – .75
Tannic (tech.)	lb.	.40 – .45	.46 – .50
Tartaric, imported crystals	lb.	..... –	.28½ – .29
Tartaric acid, imported, powdered	lb.	..... –	.29½ – .30
Tartaric acid, domestic	lb.	..... –	..... – .30
Tungstic, per lb. of WO		..... –	1.00 – 1 10
Alcohol, ethyl (Cologne spirit)	gal.	..... –	4.75 – 4.95
Alcohol, methyl (see methanol)		..... –	..... – .....
Alcohol, denatured, 188 proof No. 1	gal.	..... –	.26 – .30
Alcohol, denatured, 188 proof No. 5	gal.	..... –	.26 – .30
Alum, ammonia, lump	lb.	.03½ – .03¾	.04 – .04½
Alum, potash, lump	lb.	.03½ – .04	.04½ – .05
Alum, chrome lump	lb.	.05¼ – .05¾	.06 – .06¾
Aluminum sulphate, commercial	100 lb.	1 50 – 1.65	1.70 – 2.25
Aluminum sulphate, iron free	lb.	.02½ – .02¾	.03 – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.06½ – .07½	.07½ – .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .30½	.30½ – .31
Ammonium carbonate, powder	lb.	.07 – .07½	.07½ – .08
Ammonium nitrate	lb.	.06 – .06½	.06½ – .07½
Amylacetate tech.	gal.	..... –	2.00 – 2.25
Arsenic, white, powdered	lb.	.07½ – .07¾	.07¾ – .08
Arsenic, red, powdered	lb.	.12 – .12½	.12½ – .13
Barium carbonate	lb.	.03 – .04	.04½ – .05
Barium chloride	ton	90.00 – 95.00	100.00 – 105.00
Barium dioxide (peroxide)	lb.	.20 – .21	.21½ – .22
Barium nitrate	lb.	.07 – .07½	.07½ – .08
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04½	.04½ – .04¾
Blanc fixe, dry		.04 – .04½	..... – .....
Blanc fixe, pulp	ton	45.00 – 55.00	..... – .....
Bleaching powder	100 lb.	1 60 – 1.75	1.85 – 2.50
Blue vitriol (see copper sulphate)		..... –	..... – .....
Borax	lb.	.05½ – .05¾	.06 – .06¾
Brimstone (see sulphur, roll)		..... –	..... – .....
Bromine	lb.	.27 – .28	.28½ – .35
Calcium acetate	100 lbs.	1 75 – 2 00	..... – .....
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	24 00 – 24 50	24 75 – 27 00
Calcium chloride, granulated	lb.	.01½ – .01¾	.02 – .02¼
Calcium peroxide	lb.	..... –	1 40 – 1 50
Calcium phosphate, tribasic	lb.	..... –	.15 – .16
Camphor	lb.	..... –	.79 – .83
Carbon bisulphide	lb.	.06½ – .06¾	.07 – .07½
Carbon tetrachloride, drums	lb.	.09½ – .10	.10½ – .12
Carbonyl chloride, (phosgene)	lb.	..... –	.60 – .75
Caustic potash (see potassium hydroxide)		..... –	..... – .....
Caustic soda (see sodium hydroxide)		..... –	..... – .....
Chalk, precip.—domestic, light	lb.	.04½ – .04¾	..... – .....
Chalk, precip.—domestic, heavy	lb.	.03½ – .03¾	..... – .....
Chalk, precip.—imported, light	lb.	.04½ – .05	..... – .....
Chlorine, gas, liquid-cylinder (100 lb.)	lb.	.05 – .05½	.05½ – .06
Chloroform	lb.	..... –	.30 – .32
Cobalt oxide	lb.	..... –	2.00 – 2.10
Copperas	ton	20 00 – 22 00	23 00 – 30 00
Copper carbonate, green precipitate	lb.	.19 – .20	.20½ – .21
Copper cyanide	lb.	..... –	.58 – .60
Copper sulphate, crystals	100 lb.	6.00 – 6.15	6.25 – 6.50
Cream of tartar	lb.	..... –	.24 – .25
Epsom salt (see magnesium sulphate)		..... –	..... – .....
Ethyl acetate com. 85%	gal.	..... –	.60 – .65
Ethyl acetate, pure (acetic ether, 98% to 100%)	gal.	..... –	.90 – .95
Formaldehyde, 40 per cent	lb.	.08½ – .08¾	.08½ – .09
Fullers earth, f.o.b. mines	net ton	16.00 – 17.00	..... – .....
Fullers earth—imported powdered—net	ton	30.00 – 32.00	..... – .....
Fusel oil, ref.	gal.	..... –	2.25 – 2.65
Fusel oil, crude	gal.	..... –	1.25 – 1.45
Glauber's salt (see sodium sulphate)		..... –	..... – .....
Glycerine, c. p. drums extra	lb.	..... –	.14½ – .15½
Iodine, resublimed	lb.	..... –	4.20 – 4.25
Iron oxide, red	lb.	..... –	.12 – .18
Lead acetate	lb.	..... –	.09½ – .12
Lead arsenate, powd.	lb.	.13½ – .14	.14½ – .15
Lead nitrate	lb.	..... –	.15 – .20
Litharge	lb.	.07½ – .08	.08 – .09
Magnesium carbonate, technical	lb.	.08½ – .08¾	.09 – .09½
Magnesium sulphate, U. S. P.	100 lb.	2.50 – 2.60	2.65 – 2.85
Magnesium sulphate, technical	100 lb.	..... –	1.70 – 1.80
Methanol, 95%	gal.	..... –	.57 – .58
Methanol, 97%	gal.	..... –	.59 – .60
Nickel salt, double	lb.	..... –	.11 – .11½
Nickel salt, single	lb.	..... –	.10 – .10½
Phogene (see carbonyl chloride)		..... –	..... – .....
Phosphorus, red	lb.	..... –	.40 – .45
Phosphorus, yellow	lb.	..... –	.30 – .35
Potassium bichromate	lb.	.09¼ – .10	.10¼ – .10
Potassium bromide, granular	lb.	..... –	.17 – .23
Potassium carbonate, U. S. P.	lb.	.12 – .12½	.13 – .16
Potassium carbonate, 80–85%	lb.	.04½ – .05	.05½ – .06
Potassium chlorate, powdered and crystals	lb.	.06½ – .07	.07½ – .08
Potassium cyanide	lb.	..... –	.45 – .50
Potassium hydroxide (caustic potash)	100 lb.	5.75 – 6.00	6.25 – 6.50
Potassium iodide	lb.	..... –	3.30 – 3.40
Potassium nitrate	lb.	.06½ – .07	.07½ – .08
Potassium permanganate	lb.	.14 – .14½	.14½ – .15½
Potassium prussiate, red	lb.	..... –	.80 – .85
Potassium prussiate, yellow	lb.	.32 – .32½	.32½ – .33
Rochelle salts (see sodium potas. tartrate)		..... –	..... – .....
Salammoniac, white, granular	lb.	.06½ – .07	.07½ – .08
Salammoniac, gray, granular	lb.	.07½ – .08	.08½ – .08¾
Salsoda	100 lb.	1.20 – 1.40	1.45 – 1.60
Salt cake (bulk)	ton	20.00 – 25.00	..... – .....
Soda ash, light, 58 per cent flat, bags, contract	100 lb.	1.65 – 1.70	2.00 – 2.25
Soda ash, light, 58 per cent flat, bags, resale	100 lb.	1 80 – 1.90	1.95 – 2 40
Soda ash, dense, in bags, resale	100 lb.	1.90 – 1.95	2.00 – 2.50
Sodium acetate	lb.	.05½ – .06	.06½ – .06¾
Sodium bicarbonate	100 lb.	1.75 – 1.85	1.90 – 2.30
Sodium bichromate	lb.	.07½ – .07¾	.07½ – .08
Sodium bisulphate (nitre cake)	ton	4.50 – 4.60	4.65 – 5.50
Sodium bisulphite powdered, U.S.P.	lb.	.04½ – .04¾	.04½ – .05¼
Sodium chlorate	lb.	.06½ – .06¾	.07 – .07½
Sodium chloride	long ton	12.00 – 13.00	..... – .....
Sodium cyanide	lb.	.22 – .23	.23½ – .25
Sodium fluoride	lb.	.10 – .10½	.10½ – .11
Sodium hydroxide (caustic soda) solid, 76 per cent flat, drums, contract	100 lb.	3.35 – 3.50	3.80 – 4.00
Sodium hydroxide (caustic soda) solid, 76% flat, drums, resale	100 lb.	3.80 – 3.85	3.90 – 4.20
Sodium hydroxide (caustic soda), ground and flake, contracts	100 lb.	3.85 – 4.00	4.30 – 4.50
Sodium hydroxide (caustic soda) ground and flake, resale	100 lb.	4.00 – 4.15	4.40 – 4.60
Sodium hyposulphite	lb.	.03 – .03¼	.03½ – .04
Sodium nitrite	lb.	.08½ – .08¾	.09 – .09½
Sodium peroxide, powdered	lb.	.28 – .30	.31 – .35
Sodium phosphate, dibasic	lb.	.03½ – .04	.04½ – .04¾
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.18 – .21
Sodium prussiate, yellow	lb.	.21 – .21½	.22 – .23
Sodium silicate, (40 deg. in drums)	100 lb.	.80 – 1.00	1.05 – 1.25
Sodium silicate, (60 deg. in drums)	100 lb.	2.25 – 2.40	2.45 – 2.75
Sodium sulphate, crystals (glaubers salt)	100 lbs.	.95 – 1.05	1.15 – 1.50
Sodium sulphide, fused, 60-62 per cent (cone.)	lb.	.04½ – .04¾	.04½ – .05
Sodium sulphite, crystals	lb.	.03½ – .03¾	.03½ – .04¾
Strontium nitrate, powdered	lb.	.09½ – .10	.10½ – .12
Sulphur chloride, yellow	lb.	.04½ – .05	.05½ – .06
Sulphur, crude	ton	18.00 – 20.00	..... – .....
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Talc—imported	ton	30 00 – 40 00	..... – .....
Talc—domestic powdered	ton	18.00 – 25 00	..... – .....
Tin bichloride	lb.	.09 – .09½	.09½ – .10
Tin oxide	lb.	..... –	.35 – .37
Zinc carbonate	lb.	.14 – .14½	.14½ – .15½
Zinc chloride, gran.	lb.	.05½ – .05¾	.05¾ – .06½
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc oxide, XX	lb.	.07½ – .08	.08¼ – .08½
Zinc sulphate	100 lb.	2 75 – 3.00	3.05 – 3.30

Coal-Tar Products

NOTE—These prices are for original packages in large quantities f.o.b. N.Y.:

Alpha-naphthol, crude	lb.	$1.00 — $1 05
Alpha-naphthol, refined	lb.	1.10 — 1.15
Alpha-naphthylamine	lb.	.30 — .31
Aniline oil, drums extra	lb.	.14 — .16
Aniline salts	lb.	.22 — .24
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.25 — 1.30
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.28 — .32
Benzidine, base	lb.	.85 — .95
Benzidine sulphate	lb	.80 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.50 — .55
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech.	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.75 — 4.00
Beta-naphthol, sublimed	lb.	.50 — .55
Beta-naphthol, tech	lb.	.23 — .26
Beta-naphthyla mine, sublimed	lb.	1.50 — 1.60
Carbazol	lb.	.75 — .90
Cresol, U. S. P., in drums (100 lb.)	lb.	.12 — .15
Ortho-cresol, in drums (100 lb.)	lb.	.16 — .18
Cresylic acid, 97–99%, straw color, in drums	gal.	.56 — .65
Cresylic acid, 95-97%, dark, in drums	gal.	.51 — .58
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	.65 — .70
Dimethylaniline	lb.	.36 — .38
Dinitrobenzene	lb.	.22 — .25
Dinitroclorbenzene	lb.	.22 — .24
Dinitronaphthalene	lb.	.30 — .32
Dinitrophenol	lb.	.33 — .35
Dinitrotoluene	lb.	.22 — .24
Dip oil, 25%, car lots, in drums	gal.	.24 — .26
Diphenylamine	lb.	.59 — .65
H-acid	lb.	.80 — .95
Meta-phenylenediamine	lb.	.90 — 1.00
Monochlorbenzene	lb.	.09 — .11
Monoethylaniline	lb.	1.00 — 1.20
Naphthalene crushed, in bbls.	lb.	.06 — .06¼
Naphthalene, flake	lb.	.06½ — .07
Naphthalene, balls	lb.	.08 — .08
Naphthionate of soda	lb.	.58 — .65
Naphthionic acid, crude	lb.	.65 — .70
Nitrobenzene	lb.	.10 — .12
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.15 — .17
N-W acid	lb.	1.15 — 1.30
Ortho-amidophenol	lb.	.40 — 2.50
Ortho-dichlor-benzene	lb.	2.15 — .20
Ortho-nitro-phenol	lb.	.70 — .75

Ortho-nitro-toluene	lb.	$0.10 —	$0.13
Ortho-toluidine	lb.	.14 —	.18
Para-amidophenol, base	lb.	1.25 —	1.30
Para-amidophenol, HCl	lb.	1.30 —	1.35
Para-dichlorbensene	lb.	.17 —	20
Paranitroaniline	lb.	.72 —	.75
Para-nitrotoluene	lb.	.55 —	.65
Para-phenylenediamine	lb.	1.55 —	1.60
Para-toluidine	lb.	.90 —	1.00
Phthalic anhydride	lb.	.35 —	.38
Phenol, U. S. P., drums	lb.	.14 —	15
Pyridine	gal.	1.75 —	2.75
Resorcinol, technical	lb.	1.30 —	1.35
Resorcinol, pure	lb.	1.75 —	1.80
R-salt	lb.	.60 —	.70
Salicylic acid, tech., in bbls	lb.	.25 —	.25½
Salicylic acid, U. S. P	lb.	.26 —	.26½
Solvent naphtha, water-white, in drums, 100 gal	gal.	.27 —	.32
Solvent naphtha, crude, heavy, in drums, 100 gal	gal.	.14 —	.18
Sulphanilic acid, crude	lb.	.24 —	.26
Tolidine	lb.	1.20 —	1.30
Toluidine, mixed	lb.	.30 —	.35
Toluene, in tank cars	gal.	.25 —	28
Toluene, in drums	gal.	.30 —	.35
Xylidines, drums, 100 gal	lb.	.40 —	.45
Xylene, pure, in drums	gal.	.40 —	.45
Xylene, pure, in tank cars	gal.	.45 —	....
Xylene, commercial, in drums, 100 gal	gal.	.33 —	.35
Xylene, commercial, in tank cars	gal.	.30 —	....

Waxes

Prices based on original packages in large quantities f.o.b. N.Y.

Bayberry Wax	lb.	$0.21 —	$0.22
Beeswax, refined, dark	lb.	.30 —	.32
Beeswax, refined, light	lb.	.34 —	.35
Beeswax, white pure	lb.	.38 —	.40
Candellila, wax	lb.	.25 —	.30
Carnauba, No. 1	lb.	.42 —	.44
Carnauba No. 2, North Country	lb.	.24 —	.25
Carnauba, No. 3, North Country	lb.	.16 —	.16½
Japan	lb.	.16 —	.16½
Montan, crude	lb.	.04½ —	.04½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ —	....
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ —	....
Paraffine waxes, refined, 118-120 m.p.	lb.	.03½ —	.03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½ —	.03½
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 —	.04½
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ —	.04½
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 —	.05½
Stearic acid, single pressed	lb.	.09 —	.09½
Stearic acid, double pressed	lb.	.09½ —	.09½
Stearic acid, triple pressed	lb.	.10½ —	.10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50 gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl	280 lb.	$5.25 —	$5.35
Rosin E-I	280 lb.	5.60 —	5.65
Rosin K-N	280 lb.	6.15 —	6.70
Rosin W. G.-W. W	280 lb.	7.60 —	8.25
Wood rosin, bbl	280 lb.	6.25 —	....
Spirits of turpentine	gal.	1.00 —	1.01
Wood turpentine, steam dist	gal.	.85 —	....
Wood turpentine, dest. dist	gal.	.70 —	.70
Pine tar pitch, bbl	200 lb.	..... —	6.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	9.50
Retort tar, bbl	500 lb.	—	9.00
Rosin oil, first run	gal.	.36 —	.....
Rosin oil, second run	gal.	.38 —	.....
Rosin oil, third run	gal.	.46 —	.....
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		1.00
Pine oil, pure, dest. dist	gal.		.95
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.25
Pinewood creosote, ref	gal.		.52

Fertilizers

Prices remain same as previous report.

Crude Rubber

Quotations remain same as June 14th report.

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls	lb.	$0.11 —	$0.11½
Castor oil, AA, in bbls	lb.	.12 —	.12½
China wood oil, in bbls	lb.	.13½ —	.14
Cocoanut oil, Ceylon grade, in bbls	lb.	.08½ —	.08½
Cocoanut oil, Cochin grade, in bbls	lb.	.09½ —	.09½
Corn oil, crude, in bbls	lb.	.11½ —	.11½
Cottonseed oil, crude (f. o. b. mill)	lb.	$0.10 —	$0.10
Cottonseed oil, summer yellow	lb.	.11½ —	.12
Cottonseed oil, winter yellow	lb.	.12½ —	.13
Linseed oil, raw, car lots (domestic)	gal.	.80 —	.81
Linseed oil, raw, tank cars (domestic)	gal.	.76 —	.78
Linseed oil, boiled, in 5-bbl lots (domestic)	gal.	.85 —	.86
Olive oil, denatured	gal.	1.15 —	1.17
Palm, Lagos	lb.	.07½ —	.07
Palm, Niger	lb.	.06½ —	.06
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10 —	.10½
Peanut oil, refined, in bbls	lb.	.12½ —	.12½
Rapeseed oil, refined in bbls	gal.	.84 —	.85
Rapeseed oil, blown, in bbls	gal.	.87 —	.88
Soya bean oil (Manchurian), in bbls. N. Y	lb.	.12½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10½ —	....

FISH

Light pressed menhaden	gal.	$0.51 —	....
Yellow bleached menhaden	gal.	.53 —	.54
White bleached menhaden	gal.	.55 —	.56
Blown menhaden	gal.	.61 —	....
Whale O.l, No. 1. crude, tanks, coast	gal.	.45 —	.48

Refractories

Prices remain quotably unchanged.

Ferro-Alloys

Ferrotitanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochromium, per lb. of Cr contained, 6-8% carbon, carlots	lb.	.11 —	....
Ferrochromium, per lb. of Cr contained, 4-6% carbon, carlots	lb.	.12 —	....
Ferromanganese, 78-82% Mn, domestic	gross ton	67.00 —	69.00
Ferromanganese, 78-82% Mn, German	gross ton	66.00 —	66.50
Spiegeleisen, 19-21% Mn	gross ton	36.00 —	....
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.00 —	2.25
Ferrosilicon, 10-15%	gross ton	38.00 —	40.00
Ferrosilicon, 50%	gross ton	58.00 —	60.00
Ferrosilicon 75%	gross ton	115.00 —	120.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45 —	.50
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V.	lb.	3.00 —	3.50

Ores and Semi-finished Products

Fluorspar, gravel, f.o.b. mines New Mexico, net ton, $15.00.
Fluorspar, standard, domestic washed gravel, Kentucky, and Illinois mines, net ton, $17.50—19.00
All other prices remain unchanged.

Miscellaneous Materials

Shellac, orange fine	lb.	.80 —	.81
Shellac, orange superfine	lb.	.82 —	.84
Shellac, A. C. garnet	lb.	.67 —	.68
Shellac, T. N.	lb.	.78 —	.80

All other quotations remain same as previous report.

Non-Ferrous Metals

All f.o.b. New York Unless Otherwise Stated

	Cents per Lb.
Copper, electrolytic	13.875
Aluminum, 98 to 99 per cent	19.00–20.00
Antimony, wholesale lots, Chinese and Japanese	5.25–5.30
Nickel, ordinary (ingot)	36.00
Nickel, electrolytic	39.00
Nickel, electrolytic, resale	32.00–33.00
Nickel, ingot and shot, resale	29.00–31.00
Monel metal, shot and blocks	32.00
Monel metal, ingots	35.00
Monel metal, sheet bars	38.00
Tin, 5-ton lots, Straits	31.125
Lead, New York, spot	5.75
Lead, E. St. Louis, spot	5.625
Zinc, spot, New York	5.75
Zinc, spot, E. St. Louis	5.425

All other quotations are unchanged

OTHER METALS

Silver (commercial)	oz.	$0.71½
Cadmium	lb.	1.15–1.20
Bismuth (500 lb. lots)	lb.	2.00@2.10
Cobalt	lb.	3.00@3.25
Magnesium, ingots, 99 per cent	lb.	1.10
Platinum	oz.	87.50
Iridium	oz.	150.00@170.00
Palladium	oz.	55.00@ 57.50
Mercury	75 lb.	55.00@ 56.00

FINISHED METAL PRODUCTS

All quotations remain unchanged.

Structural Material

Prices remain same as previous report.

Industrial

Financial, Construction and Manufacturers' News

Industrial Developments

GLASS—The United States Glass Co., Tiffin, O., has fired a second furnace at its plant, increasing the output from 52 to 80 per cent of normal. The works have been placed on full time operating basis, in different departments, giving employment to about 400 men.

The Interstate Window Glass Co., Smethport, Pa., is arranging for the early resumption of operations at its local plant, following a curtailment for some time past.

Following the refusal of a request from operatives for a wage increase, the Consolidated Window Glass Co., Mount Jewett, Pa., has closed its local plant until further notice.

CERAMIC—The Finzer Brothers Clay Co., Sugarcreek, O., manufacturer of face brick and kindred products, is increasing operations at its plant. During the month of May the company made a record output comprising 137 carloads of material, aggregating 1,305,000 bricks.

The Fords Porcelain Works, Perth Amboy, N. J., manufacturer of sanitary ware, is running full at its two local plants, as well as factory at Fords, near Perth Amboy.

RUBBER—The Republic Rubber Corp., Youngstown, O., is increasing production in its mechanical rubber goods department. The Canton, O., works is running on an advanced working schedule, with output averaging 1,500 automobile tires daily.

The Burdick Tire & Rubber Co., Noblesville, Ind., will commence operations at its local plant in July. The works has been completed for a number of months, but has been kept idle until conditions warranted manufacture. The plant has a capacity of 5,000 tires a day, and it is expected to develop this output at an early date. Employment will be given to about 100 men for initial production.

All plants at Akron, O., devoted to the manufacture of mechanical rubber goods, have been placed on a capacity basis with regular operating forces.

The Howe Rubber Corp., New Brunswick, N. J., is increasing operations at its plant in the line of automobile tires. Sales during the month of May were the largest in the history of the company.

The McGraw Tire & Rubber Co., New York, N. Y., has advanced production at its plant to 2,200 casings and 1,500 inner tubes per day. It is expected to make further increase in this output at an early date.

IRON AND STEEL—The Carnegie Steel Co. is arranging for the resumption of operations at six additional open-hearth furnaces and one blast furnace at its Sharon, Pa., plant, bringing production up to close to normal, or full capacity basis. About 1,000 men will be added to the working force.

The United Alloy Steel Corp. has resumed operations at the plant of the Canton Sheet Steel Co., Canton, O., recently acquired, placing four mills in service. Other mills and departments will be reopened at an early date. It is expected to employ a regular working quota of 1,800 men.

The Youngstown Sheet & Tube Co., Youngstown, O., is making ready for operations at its Hubbard plant, which has been idle for some time past. It is said that both blast furnaces will be blown in as soon as the coal supply improves.

The British Empire Steel Corp. is increasing operations at its plant at Sydney, N. S., giving employment to 1,900 men as against a working force of 1,200 on May 1. Additions will be made to this number in the near future.

The Wheeling Steel Corp., Wheeling, W. Va., has reopened the sheet mill at the plant of its Whitaker-Giessner division, Martin's Ferry, O., following a shutdown since the spring of 1921. It is expected to reach the full working quota of 800 men in the near future. The company has advanced the wages of all hourly workers at its different plants at Steubenville, Beech Bottom and Martin's Ferry about 10 per cent.

The National Tube Co., Lorain, O., has increased production to about 80 per cent of capacity at its local plant, which, due to works expansion, exceeds regular production during the pre-war period.

The Eastern Steel Co. is making repairs to the machinery in the blooming mill at its Pottsville, Pa., works, and plans to place the unit in service at an early date. Work will be resumed at the 28-in. mill at the same time.

The Republic Iron & Steel Co. is arranging for the resumption of operations at its rerolling bar mill at Moline, Ill., after a shutdown since early in 1921.

MISCELLANEOUS—The Glidden Co., Cleveland, O., manufacturer of paints, varnishes, etc., is running its five plants on a full-time capacity basis, with 24-hour working schedule.

The Bartlesville Zinc Co., Bartlesville, Okla., is arranging for the resumption of operations at its Blackwell, Okla., smelting plant, following a suspension since last January. Employment will be given to about 400 men.

The Alabama By-Products Corp., Birmingham, Ala., is operating at full capacity and has plans under way for the early erection of twenty-five additional Koppers coke ovens to increase the output by about 50 per cent.

The International Nickel Co., New York, N. Y., has resumed operations at its Port Colborne, Ont., refining plant, after a shutdown for a number of months past. Production at the smelting plant at the works will be deferred for the present.

The United States Cast Iron Pipe Co. has advanced production to about 80 per cent of capacity at its plants at Bessemer and Anniston, Ala., and Chattanooga, Tenn.

The American Smelting & Refining Co. is increasing production at its Perth Amboy, N. J., plant. The working force has been advanced to close to 1,000 men, and further additions will be made at an early date.

Construction and Operation

Alabama

LA PINE — The A. E. Davis Permanent Ink Co. has recently organized under Delaware laws, with capital of $100,000, and is arranging for the establishment of a local plant for the manufacture of ink products, and is making inquiries for equipment, including ink-mixing machines, with capacity of about 75 gal. each. A. E. Davis, Sellers, Ark., is president; and T. A. Bullard, La Pine, general manager.

California

RICHMOND—James Hyslop has leased the local plant of the Coast Brick Co., and will operate the works for the manufacture of glazed and colored tile, and other burned clay products.

LOS ANGELES—Water-softening equipment, air compressors, cooling coils, brine tank, pumping machinery, etc., will be installed in the new plant to be constructed by the Mutual Dairy Co., Maomi and Walnut Sts. Clifford A. Truesdell, Jr., Purington & Newton, 303-7 San Fernando Bldg., associated engineers, are preparing plans.

Florida

MIAMI—The Tropical Fruit Conserving Co., 1444 West Miami Ave., will commence the immediate erection of a new 1-story plant, 75x180 ft., for the manufacture of coconut sirup and kindred specialties. The installation will include pressure cookers, aluminum vats, mixing machinery, etc. Samuel V. Aston is general manager.

GAINESVILLE—The Vego-Hair Mfg. Co., manufacturer of fiber products, is arranging for the rebuilding of the portion of its plant recently destroyed by fire, to comprise three 1-story buildings, each about 30x60 ft. A. H. Selle is general manager.

Illinois

CHICAGO—A 1-story foundry, 60x100 ft., to cost close to $50,000, will be constructed by the Chicago Hardware Foundry Co., 546 West Washington Blvd., at its plant at North Chicago.

CHICAGO—The Chicago Pottery Co., 1924 Clybourn Ave., has filed plans and commenced excavations for the erection of its proposed 2-story addition, 113x190 ft. Contract has been let to Bulley & Andrews, 25 North Dearborn St. L. E. Russell, 25 North Dearborn St., is architect.

LITCHFIELD—The City Council will call for bids about July 15, for the construction of a new filtration plant in connection with improvements in the waterworks system, estimated to cost about $300,000. The Pierce, Greeley & Hanson Engineering Co., 39 South Adams St., Chicago, is engineer.

Indiana

NOBLESVILLE—The New Process Steel Co. is completing construction work on its new local plant, and plans to have the works ready for operation early in July. Employment will be given to about 100 men for initial operations.

Kansas

LEAVENWORTH—The Great Western Stove Co. will build a 2-story and basement addition to its plant at 2nd and Choctaw Sts., to be equipped as an enameling department. W. R. and M. K. Foth, Leavenworth, are architects.

Louisiana

NEW ORLEANS—The Baldwin Petrinite Roofing Tile Co., manufacturer of composition roofing tiles and kindred products, is planning for the installation of additional machinery at its new local plant. Enos Baldwin is general manager.

Maine

TOPSHAM—The Pejepscot Paper Co., operating mills at Topsham, Pejepscot, Lisbon Falls and Bowdoin, Me., for the manufacture of newsprint, pulp, etc., has preliminary plans under way for extensions and improvements for considerable increase in capacity. The work is estimated to cost close to $1,000,000. Edgar Rickard is president, and Fred C. Clark, vice-president and general manager. The company is a subsidiary of the International Development Co.

Massachusetts

MARLBORO — The Dennison Mfg. Co., Framingham, has construction under way on its proposed new local plant for the manufacture of paper specialties, and plans to occupy the structure at the earliest date. It will be 4-story, reinforced-concrete, 70x300 ft., and estimated to cost close to $100,000, including machinery.

Michigan

FLAT ROCK—The Ford Motor Co., Highland Park, has plans in progress for the erection of a new local 1- and 2-story plant at Flat Rock, for the manufacture of glass products, including windshield glass, etc., for Ford automobiles. It is estimated to cost close to $1,000,000, including machinery. Albert Kahn, 1,000 Marquette Bldg., Detroit, is architect.

KALAMAZOO—The Kalamazoo Vegetable Parchment Co., manufacturer of parchment papers, is taking bids on a general contract for the erection of a 2-story plant addition, estimated to cost close to $400,000, including machinery. Billingham & Cobb, Press Bldg., Kalamazoo, are architects. J. Kindleberger is president and general manager.

KALAMAZOO — The Birmingham & Prosser Co., paper products, will construct a new building at its works, 54x166 ft., to cost about $75,000.

Missouri

POPLAR BLUFF—W. S. Hooper, president of the Ozark Ore & Mfg. Co., is at the head of a project to construct and operate a plant near St. Louis, for the manufacture of general chinaware products, estimated to cost in excess of $250,000, including machinery. It is said that a company will be organized to operate the proposed plant.

KANSAS CITY—The Standard Foundry & Mfg. Co., 204 Security Bldg., recently organized, will soon commence the erection of a new 1-story foundry, 90x120 ft., for

the manufacture of a general line of castings. W. H. Simpson is president, and J. B. Harden, secretary and treasurer.

New Jersey

TRENTON—The Unitco Pottery Co., Frazier St., will make extensions and improvements in the kiln department at its plant.

BAYONNE—The chemical laboratory at the plant of the Nucoa Butter Co., Ave. A and 4th St. was damaged by fire, caused by an explosion, June 8. An official estimate of loss has not been made.

Ohio

GOSHEN—S. P. Myers and S. O. McFall, officials of the Uhrichsville (Ohio) Sewer Pipe Co., have acquired the partly completed plant of the H. C. Schneider Sewer Pipe Co., Goshen, designed for the manufacture of vitrified sewer pipe, and adjoining clay properties. The new owners will organize a company to operate the plant, and purpose to complete the final plant units at an early date. The property was purchased for a consideration said to be $146,000.

AKRON—The International Lead Co., a subsidiary of the Anaconda Copper Co., 25 Broadway, New York, N. Y., is investigating local sites with view to the erection of a new plant for the manufacture of zinc oxides and compounds used in the production of rubber products. The proposed works will consist of a number of buildings, estimated to cost close to $1,000,000, including machinery. William Wraith is president.

Pennsylvania

PHILADELPHIA — The Philadelphia Paper Mfg. Co., River Rd., has broken ground for the erection of a new 1-story plant, 120x270 ft., at Umbria, Nixon and Founton Sts., estimated to cost about $60,000. The Hughes-Foulkrod Co., 1201 Chestnut St., has the construction contract. John Jacobs, Jr., is president.

PITTSBURGH—The Young Paper Mfg. Co., 34th St. and the Allegheny Valley Railroad, manufacturer of prepared roofing papers, etc., has preliminary plans under way for the rebuilding of the portion of its plant destroyed by fire, June 8, with loss approximating $100,000, including equipment. The same fire also destroyed a section of the foundry of the Pittsburgh Malleable Iron Co., 34th and Smallman Sts., with loss of about $40,000.

PHILADELPHIA—The Grasselli Chemical Co., 908 Chestnut St., has leased the 3-story building at 909 Sansom St., and will equip the structure for general operating service. Headquarters of the company are in the Guardian Bldg., Cleveland, O.

MARCUS HOOK—The Sun Co., Finance Bldg., Philadelphia, Pa., has commenced the rebuilding of the grease-manufacturing plant at its oil refinery, Marcus Hook, recently destroyed by fire, with loss approximating $60,000, including equipment. The new building will be 75x168 ft.

PHILADELPHIA—The National Ammonia Co. of Pennsylvania, Van Kirk St., has filed plans for the construction of a new building at its plant, to cost about $30,000. The erection contract has been let to E. E. Hollenbeck, Inc., 1804 Brandywine St.

PHILADELPHIA — The Wittman-Moriarty Co., 4th and Vine Sts., manufacturer of leather products, has construction under way and plans for the early occupancy of the new 1- and 2-story addition to its tannery at Ontario and C Sts., estimated to cost about $75,000. J. P. Wittman is president and treasurer.

PHILADELPHIA — The Hurlock Brothers Co., 3436 Market St., manufacturer of cardboard specialties and kindred products, has work under way on an addition to its plant, to cost about $10,000.

South Carolina

GREENVILLE—The Boll-We-Go Mfg. Co., recently organized, has plans under way for the establishment of a local plant for the manufacture of chemical compound products. Homer L. Todd is president.

Tennessee

COPPERHILL—The Tennessee Copper Co., 61 Broadway, New York, N. Y., has work under way on plant additions, including flotation expansion, with capacity of about 500 tons. J. N. Houser is general manager.

Texas

EL PASO—The J. M. Booth Chemical Co., manufacturer of sal soda and kindred products, has preliminary plans under way for the construction of an addition to its plant. Joseph M. Booth is president.

DALLAS—The Lignite Industries Corp., St. Paul, Minn., has organized a subsidiary company to be known as the Texas Lignite Co., for the construction and operation of a series of six plants in this state, to be located at Dallas, Fort Worth, Galveston, Houston, Greenville and one other point to be selected. Plans are under way for the initial works for the production of pressed briquets, with large chemical byproduct plant to be used for ammonia, carbolic acid, lubricating oil and paraffin manufacture. The entire project is estimated to cost close to $200,000, including equipment. Carl Jaeger is president and chemical engineer.

DALLAS—The Dallas Gas Co. has preliminary plans under consideration for extensions and improvements in its plant and system, to cost in excess of $300,000.

Virginia

RICHMOND—The Fibre Board Container Co., 3200 Williamsburg Ave., has plans under way for extensions in its plant, to double, approximately, the present output. D. J. Donati is president.

BUENA VISTA—The United Chemical Products Co., Chamber of Commerce Bldg., Pittsburgh, Pa., is taking bids for the construction of a new local plant, 1-story, 41x145 ft., estimated to cost close to $50,000. F. B. Doane is company engineer.

HEATHSVILLE—The Cherrystone Fish Oil Co., recently organized, has acquired the plant of the Cherrystone Oil & Guano Co., and will operate the works for the production of commercial fish-oil products. Improvements are being considered. T. H. Fallin, Coan, Va., is president; and A. J. Lewis, vice-president.

West Virginia

PIEDMONT—The Potomac Fire Brick Co. has commenced the installation of new machinery at its plant for considerable increased capacity.

WELLSBURG—The Hammond Bag & Paper Co., recently organized with a capital of $500,000, has plans in preparation for the construction of a new 1-story plant, 125x500 ft., for the manufacture of paper products. T. H. Hammond is president; and D. A. Burt vice-president.

LANSING—The Shawner Construction Co. has commenced the erection of a new 1-story plant on local site, for the manufacture of cement bricks, blocks and kindred products. A list of equipment for installation is being arranged. J. A. Ellison is general manager.

Canada

TODMORDEN, ONT.—The Don Valley Paper Co., Ltd., Don Mills section, is planning for the rebuilding of the portion of its plant, destroyed by fire, May 31, with loss approximating $100,000, including equipment.

New Companies

THE BERKSHIRE COATED PAPER CO., Great Barrington, Mass., has been incorporated with a capital of $75,000, to manufacture paper products. Jeremiah H. Whitehouse, 77 Firglade Ave., Springfield, Mass., is president and treasurer.

THE S. & S. CHEMICAL CO., care of William Charlton, 404 Guarantee Trust Bldg., Atlantic City, N. J., representative, has been incorporated under state laws with capital of $50,000, to manufacture chemicals, chemical byproducts, etc. The incorporators are Lionel C. Schener, Arthur G. Walker and M. H. Sachs, all of Atlantic City.

THE AERO RUBBER PRODUCTS CORP., care of B. E. Reardon, Yonkers, N. Y., representative, has been incorporated under state laws with capital of $150,000, to manufacture rubber products. The incorporators are I. R. Davies, J. P. and I. Todd, all of Yonkers.

THE ATLAS ASBESTOS CO., Norristown, Pa., has been incorporated with a capital of $25,000, to manufacture asbestos products. J. C. Johnston, Norristown, is treasurer.

THE LATHROAL SOAP CO., Tallahassee, Fla., has been incorporated with a capital of $10,000, to manufacture soaps and affiliated products. The incorporators are J. A. O'Berry and Robert Hancock, both of Tallahassee.

THE FLEXIBLE CORK PRODUCTS CO., Jersey City, N. J., has been incorporated with a capital of 7,000 shares of stock, no par value, to manufacture cork specialties. The incorporators are John C. and Grier P. Manning, and John P. Taggart, 737 Communipaw Ave., Jersey City.

THE REIBER-ZIEGLER CORP., care of Louis Levy, 277 Broadway, New York, N. Y., representative, has been incorporated under state laws with capital of $20,000, to manufacture chemicals, paints, etc. The incorporators are M. and S. A. Reiber, and E. D. Ziegler, all of New York.

THE MILLION DOLLAR CHEMICAL CO., Cleveland, O., has been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The incorporators are Joseph H. Crowley and Sidney N. Weitz, Tenth Floor, B. of L. E. Bldg., Cleveland.

THE SOUTHWESTERN OIL PRODUCING CORP., care of Arley B. Magee, Dover, Del., has been incorporated under state laws with capital of $9,000,000, to manufacture petroleum products.

THE ELECTRO-MOULDED PRODUCTS CORP., Arlington, Mass., has been incorporated with a capital of 50 shares of stock, no par value, to manufacture composition and molded specialties. Charles E. Clarke is president; and Laurence M. Pitman, 117 Appleton St., Arlington, treasurer.

THE P. & M. BRICK MFG. CO., care of A. Simmons, New Rochelle, N. Y., attorney, representative, has been incorporated under state laws with capital of $20,000, to manufacture brick, with plant at Saugerties, N. Y. The incorporators are W. Picker, J. and R. Malakoff.

THE CHICAGO FANCY LEATHER SPECIALTIES MFG. CO., 600 Blue Island Ave., Chicago, Ill., has been chartered under state laws to manufacture leather products. The incorporators are Soren D. Mortensen, George L. Frebn and George J. Prehn.

THE KAY OIL CO., Blackwell, Okla., has been incorporated with a capital of $75,000, to manufacture petroleum products. The incorporators are W. M. Vickery, David Schonwald and H. S. Curley, all of Blackwell.

THE TEXTILE RUBBER CO., Boston, Mass., has been incorporated with a capital of $50,000, to manufacture rubber products. John E. Shannon is president; and Charles V. McManus, Lynn, Mass., treasurer and representative.

THE ALUMINUM CONTAINER CORP., care of Piper & Pendergast, Fulton, N. Y., representatives has been incorporated under state laws with a capital of $200,000, to manufacture aluminum products. The incorporators are F. A. Stafford, S. M. Stevenson and C. Jensvold, all of Fulton.

THE PERUVIAN COMPOSITION PRODUCTS CORP., care of the Colonial Charter Co., Ford Bldg., Wilmington, Del., representative, has been incorporated with a capital of $1,250,000, to manufacture brass, steel and affiliated products.

THE LIMESTONE PRODUCTS CO., Menominee, Mich., has been incorporated with a capital of $25,000, to manufacture lime products. The incorporators are N. S. Meyers, H. J. Gram and E. P. Smith, 312 Main St., Menominee.

THE LAKE SHORE RUBBER CO., Newark, N. J., has been incorporated with a capital of $150,000, to manufacture rubber products. The incorporators are George P. Laible, Frederick G. Kautz and Henry Pomerehne, 20 Clinton St., Newark.

THE WILLMOTT OIL CORP., Okmulgee, Okla., has been incorporated with a capital of $400,000, to manufacture petroleum products. The incorporators are C. S. Willmott, John Caruthers and Joseph M. James, all of Okmulgee.

THE UTAH POTASH CO., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., has been incorporated under state laws with capital of $8,200,000, to manufacture potash products, with plant in the Utah potash fields.

THE AARD ASBESTOS COVERING CO., 2644 Wellington Ave., Chicago, Ill., has been incorporated with a nominal capital of $1,500, to manufacture asbestos specialties. The incorporators are Earl J. and Lester J. Mulligan, and M. J. Black.

THE MARTIN MINERAL PRODUCTS CO., Newark, N. J., has been incorporated with a capital of $125,000, to manufacture cleansers, chemical compounds, etc. The incorporators are William S. Wilde, Otto G. Mathede and Samuel C. Martin, 31 Clinton Street, Newark.

THE SEYD FERTILIZER & CHEMICAL CO., Boston, Mass., has filed notice of organization to manufacture chemical specialties, etc. The company is headed by R. Bryce Gemmel and Harold H. Seyd, P. O. Box 1936, Boston.

THE KENTUCKY-INDIANA OIL CORP., Richmond, Ind., has been incorporated with a capital of $100,000, to manufacture petro-

leum products. The incorporators are George N. Snyder, S. G. Smelser, Richmond; and Z. O. Avery, Lexington, Ky. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del.

THE HOLLAND OIL CO., Jamestown, N. Y., has been incorporated with a capital of $50,000, to manufacture refined oil products. The incorporators are C. A. Johnson, J. Sampson and A. W. Beckstrom, all of Jamestown. The company is represented by C. S. Grover, Jamestown, N. Y.

THE HOLLAND MAGNETO PRODUCTS CO., 337 West 12th St., Holland, Mich., has been incorporated with a capital of $25,000, to manufacture magnesite products, hollow tile and kindred specialties. The incorporators are Harry E. and Cecil Huntley, and William E. Dunn.

THE BRYER METALLIC POLISH CO., Boston, Mass., has filed notice of organization to manufacture polishes and kindred products. The company is headed by George Bryer, 97 Sudbury St., Boston.

THE LIFE SERVICE CHEMICAL LABORATORIES, INC., care of the United States Corporation Co., Pennsylvania Bldg., Philadelphia, Pa., representative, has been incorporated under Delaware laws with capital of $100,000, to manufacture chemical products, with headquarters at Philadelphia. The incorporators are Harold Colson and Harry R. Lee, Philadelphia.

THE MYERS LEHMAN CO., New York, N. Y., care of Harry Kutscher, 50 Broad St., representative, has been incorporated under state laws to manufacture paints, oils, etc. The incorporators are A. and E. Lehman, and H. F. Myers.

THE STOVER RUBBER CO., 1409 South Michigan Ave., Chicago, Ill., has been incorporated with a capital of 500 shares of stock, no par value, to manufacture rubber products. The incorporators are M. C. Suhr, E. E. Levy and I. K. Stover.

THE NEWARK ASBESTOS PRODUCTS CO., Newark, N. J., has been incorporated with a capital of $100,000, to manufacture asbestos specialties. The incorporators are Henry C. Schnening, Walter A. Cross and Myer N. Semel, 29 Essex St., Newark.

THE G. B. HAYNES OIL CO., Monroe, La., care of the Corporation Service Co., Equitable Bldg., Wilmington, Del., representative, has been incorporated under Delaware laws with capital of $250,000, to manufacture petroleum products.

THE LO-CO-MO OIL CO., 130 North Wells St., Chicago, Ill., has been incorporated with a capital of $10,000, to manufacture oil products. The incorporators are A. S. and Jean D. Salkey, and B. E. Langan.

RHODIA, INC., New York, N. Y., care of S. V. Ryan, Albany, N. Y., representative, has been incorporated with a capital of $5,000, to manufacture essential oils and affiliated products. The incorporators are A. F. Von Bernuth, J. H. Purdy, Jr., and C. A. Marshall, New York.

THE MADISON PAPER CORP., care of D. E. Keller, 51 Chambers St., New York, N. Y., has been incorporated under state laws with capital of $20,000, to manufacture paper specialties. The incorporators are E. M. Miller, J. Orozoco and M. S. Somers, all of New York.

THE PALM BEACH OIL CO., West Palm Beach, Fla., has been incorporated with a capital of $10,000, to manufacture oil products. B. D. Hartsfield is president; H. P. Jones, vice-president, and M. M. May, secretary, all of West Palm Beach.

THE CLIFTWOOD POTTERIES, INC., Morton, Ill., care of Evans, Galbraith, Sutherland & Evans, Lehmann Bldg., Peoria, Ill., has been incorporated with a capital of $60,000, to manufacture pottery and affiliated burned clay products. The incorporators are Matthew, John W. and Carl M. Rapp, all of Morton.

THE PREMAX PETROLEUM CORP., care of the Corporation Trust Co. of America, du Pont Bldg., Wilmington, Del., has been incorporated under state laws with a capital of $100,000, to manufacture petroleum products.

THE WOOD FIBRE PRODUCTS MFG. CO., New York, N. Y., care of Geza Eichhorn, 309 Broadway, representative, has been incorporated with a capital of $20,000, to manufacture fiber products. The incorporators are A. Horowitz and E. Rosenbaum.

THE TIGER OIL CO., Eldorado, Ill., has been incorporated with a capital of $30,000, to manufacture oil products. The incorporators are E. B. Brouillet, John A. Erwood and Samuel W. Latham, Eldorado. The latter is representative for the company.

THE LIBERTY CORK TILE CO., care of R. Packet, 2494 Morris Ave., New York, N. Y., representative, has been incorporated under state laws with capital of $100,000, to manufacture cork products. The incorporators are M. Rose and W. W. Meuer. Headquarters will be in Brooklyn, N. Y.

THE HY-TEST REFINING CO., Pittsburgh, Pa., represented by Charles W. Frankel, 415-19 Bakewell Bldg., is being organized under state laws to manufacture refined oil products. The company is headed by Marshall J. Vernet, I. T. Weill and Frank W. Besselman, all of Pittsburgh.

THE AMERICAN SHELLAC CO., New York, N. Y., care of M. J. Cahn, 200 Fifth Ave., has been incorporated with a capital of $20,000, to manufacture shellacs, varnishes, etc. The incorporators are J. Rosen and H. A. Solomon.

Capital Increases, etc.

THE ALLEN TIRE & RUBBER CO., Allentown, Pa., has filed notice of increase in capital from $1,000,000 to $2,500,000, for expansion.

THE JEWETT & SOWERS OIL CO., 20 West Jackson Boulevard, Chicago, Ill., has filed notice of increase in capital from $150,000 to $200,000.

THE HOME OIL CORP., San Antonio, Tex., has filed notice of change of name to the Laurel Refineries, Inc.

The plant and property of the KOSKO CLAY PRODUCTS CO., River Rd., Piscataway (Middlesex County), N. J., manufacturer of hollow tile, etc., will be sold by the receiver Victor W. Main, 147 Market St., Perth Amboy, N. J.

THE GWYNN'S FALLS PAPER CO., Gwynn's Falls, Baltimore, Md., has filed notice of increase in capital to $1,150,000.

Officials of the Beaver Board Companies, Inc., Beaver Rd., Buffalo, N. Y., have organized a subsidiary company, to be known as the BEAVER PRODUCTS CO., INC., to take over the operation of the plants of the parent corporation, for the manufacture of composition board specialties. A bond issue of $2,000,000 is being sold by the new company for general operations, expansion, etc.

THE CALLAHAN ZINC-LEAD CO., 61 Broadway, New York, N. Y., has increased its capital from 500,000 to 1,000,000 shares of stock, the proceeds to be used for plant extensions and general expansion. John Borg is president.

THE SOUTH PENN OIL CO., 424 Sixth Ave., Pittsburgh, Pa., has acquired the plants and property of the Eddystone Oil Corp., West Virginia, for a consideration said to be about $1,000,000. The property will be operated, and general expansion is planned.

THE MALLINKRODT CHEMICAL WORKS, INC., 3600 North Second St., St. Louis, Mo., is arranging for an increase in capital from $250,000 to $5,000,000, for general expansion. Edward M. Mallinkrodt is president.

THE NATIONAL OIL CO., Jersey City, N. J., has filed an involuntary petition in bankruptcy.

EDWARD ENGELMANN, INC., 37 East Houston, St., New York, N. Y., manufacturer of lithographing and other inks, has made an assignment to Edwin Weinberger, 965 Simpson St., New York.

THE REPUBLIC RUBBER CORP., Youngstown, O., has arranged for a security issue of $1,500,000, the proceeds to be used for general financing, operations, etc.

Arthur J. Stevens, president of the PARSONS PULP & LUMBER CO., Finance Bldg., Philadelphia, Pa., has been appointed receiver for the company. The company is said to have debts totaling $4,000,000, and assets in excess of $5,000,000.

Industrial Notes

The law offices of CHARLES W. HILLS, Chicago, announce that Russell P. Fischer has become associated with them in the practice of patent, trade mark, copyright, unfair competition and corporation law.

THE BUFFALO FOUNDRY & MACHINE CO., Buffalo, N. Y., has recently acquired the coppersmithing business formerly conducted by the W. A. Case & Son Mfg. Co. of Buffalo, including the copper shop equipment. This new department enables the Buffalo Foundry Co. to render a more complete service to customers, as it can now furnish all kinds of copper work, including copper-distilling apparatus, copper evaporators, copper kettles, copper vacuum pans, copper coils, etc., and do a general coppersmithing business either in new work or repairs.

J. M. Kryl, present president of the Kryl Bridge & Crane Works, Chicago, and W. H. Eichelman, until recently chief engineer of the Hamler Boiler & Tank Co. of Chicago, have recently formed a partnership which has been established in Chicago under the name of KRYL & EICHELMAN. Both men are graduate engineers, experienced in fabricating steel plate and structural iron with present facilities for handling water tanks, oil tanks, stacks, process kettles of all kinds for chemical equipment, ornamental iron and structural steel.

THE CONSOLIDATED PRODUCTS CO., New York, dealer in machinery, was the largest purchaser of equipment at the government auction sale at Nitro, W. Va., during the week of May 22. The sale brought a total of over one-half million dollars and the Consolidated company's purchases were in the neighborhood of $100,000, giving it one of the largest dealers' stocks of chemical equipment.

THE COMBUSTION ENGINEERING CORP., New York, announces that A. D. Halporn, who has been associated with the Philadelphia sales staff for some time, is now a member of the New York sales force.

THE PITTSBURGH TESTING LABORATORY announces the opening of a sales office with a complete inspection bureau at 1864 Railway Exchange Bldg., St. Louis, Mo., and the appointment of Colonel N. C. Hoyles as district manager. Colonel Hoyles is a graduate of Queens University and has also taken a post-graduate course at the University of Toronto. He entered the service of this company as an inspector at the Birmingham office; in 1914 was transferred to the Vancouver office; and at the breaking out of war he entered the service of the Canadian Army, serving with the British Pioneer Engineers Corps in France. He received decorations from both the French and British governments, and upon his release from the army in 1919 was appointed assistant sales manager at Cleveland. Since that time he has been consecutively assistant sales manager at New York and manager at Cincinnati, until his appointment to this new position.

THE AMERICAN GAS ASSOCIATION'S headquarters will be located at 342 Madison Ave., New York City, after July 1.

ORTON & STEINBRENNER CO., Chicago, Ill., manufacturer of locomotive cranes, grab buckets and coal crushers, have moved its offices from the 11th to the 19th floor of the Transportation Bldg., 608 South Dearborn St.

Coming Meetings and Events

ALPHA CHI SIGMA fraternity will hold its seventh biennial conclave at the Marquette Hotel, St. Louis Mo., June 22, 23 and 24.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold a joint meeting with the Pacific Division of the Association, on the occasion of the annual meeting of the latter, in Salt Lake City, June 22 to 24.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Pittsburgh, Pa., Sept. 5 to 9.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Montreal, Sept. 21, 22 and 23. Headquarters will be at the Windsor Hotel.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS is holding its summer meeting at Niagara Falls, Canada, June 19 to 22. Headquarters are at the Clifton Hotel.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its nineteenth annual meet at Bigwin Inn, Bigwin Island, in the Lake of Bays district, Ontario, Canada, on June 21, 22 and 23.

AMERICAN SOCIETY FOR STEEL TREATING will hold its International Steel Exposition and Convention in the General Motors Bldg., Detroit, Mich., Oct. 2 to 7.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its twenty-fifth annual meeting June 26 to July 1, at Atlantic City, N. J. Headquarters will be at the Chalfonte-Haddon Hall Hotel.

ANNUAL SAFETY CONGRESS OF THE NATIONAL SAFETY COUNCIL will be held in Detroit, Mich., Aug. 28-Sept. 2.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY will hold a meeting at Lyons, France, June 27 to 30.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (EIGHTH) will be held in New York Sept. 11-16.

NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace Dec. 7-13, with the exception of the intervening Sunday.

NEW JERSEY CHEMICAL SOCIETY will meet at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.